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RESEARCH MEMORANDUM

WIND-TUNNEL INVESTIGATION AT SUBSONIC AND SUPERSONIC SPEEDS OF A MODEL OF A TAILLESS FIGHTER AIRPLANE EMPLOYING A LOW-ASPECT-RATIO SWEPT-BACK WING - STABILITY AND CONTROL

By Willard G. Smith

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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WIND-TUNNEL INVESTIGATION AT SUBSONIC AND SUPERSONIC SPEEDS OF A MODEL OF A TAILLESS FIGHTER AIRPLANE EMPLOYING A LOW-ASPECT-RATIO SWEPT-BACK WING — STABILITY AND CONTROL

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SUMMARY

This report presents the results of a wind-tunnel investigation of the static stability and control characteristics of a model of a fighter airplane employing a low-aspect-ratio swept-back wing with trailing-edge elevons, a swept-back vertical tail, but no horizontal tail. The investigation was conducted over a Mach number range of 0.60 to 0.90 and 1.20 to 1.70, at constant Reynolds numbers of 2.0 million for the stability tests and 3.2 million for the control effectiveness tests. All results are presented in tabular form and typical data are presented in graphic form as well.

The results indicate that, for the test conditions at which the investigation was conducted, the model, with elevons undeflected, was longitudinally and directionally stable. Sufficient control effectiveness was provided by the trailing-edge elevons to permit longitudinal balance of the model to a lift coefficient of 0.44 at a Mach number of 0.90, and to lift coefficients of 0.25 and 0.11 at Mach numbers of 1.20 and 1.70, respectively. With the rudder deflected 8° and the model at an angle of attack of -0.5°, the results indicate that the model will have sufficient directional control to maintain sideslip angles of 3.6° at 0.90 Mach number and 2.3° at 1.40 Mach number.

INTRODUCTION

The stability and control effectiveness characteristics of aircraft flying at high subsonic and supersonic speeds are of paramount importance in the design of present-day fighter aircraft. A wind-tunnel investigation has recently been conducted in the Ames 6- by 6-foot supersonic wind tunnel to study the stability and control characteristics of a particular high-speed fighter model.

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The model had a low-aspect-ratio swept-back wing and a swept-back vertical tail. Two wing plan forms (the basic wing with rounded tips and a modified wing with triangular tips) were tested in the static longitudinal stability investigation. The model had no horizontal tail, longitudinal control being obtained with trailing-edge elevons. The control effectiveness for full-span constant-chord elevons on the basic-wing model was investigated through a Mach number range of 0.60 to 1.70. A limited study was also made of the effectiveness of elevons extending over approximately the outboard half of the wing panels. Rudder effectiveness was determined for the basic model at 0.90 and 1.40 Mach numbers.

NOTATION

Force coefficients are referred to the wind axes. Moment coefficients are referred to the stability axes, with the origin on the fuselage longitudinal axis at the lateral projection of the quarter-chord point of the mean aerodynamic chord. In those tests where yawing-moment coefficients were not measured, rolling-moment coefficients are referred to the fuselage longitudinal axis.

b wing span, feet

c local wing chord measured parallel to wing plane of symmetry, feet

$\bar{c}$ wing mean aerodynamic chord $\left(\dfrac{\int_0^{b/2} c^2 dy}{\int_0^{b/2} c\, dy}\right)$, feet

q free-stream dynamic pressure, pounds per square foot

C_D drag coefficient $\left(\dfrac{\text{drag}}{qS}\right)$

C_L lift coefficient $\left(\dfrac{\text{lift}}{qS}\right)$

C_c cross-wind-force coefficient $\left(\dfrac{\text{cross-wind force}}{qS}\right)$

C_h hinge-moment coefficient $\left(\dfrac{\text{hinge moment}}{2qM_a}\right)$

C_l rolling-moment coefficient $\left(\frac{\text{rolling moment}}{qSb}\right)$

C_m pitching-moment coefficient $\left(\frac{\text{pitching moment}}{qS\bar{c}}\right)$

C_n yawing-moment coefficient $\left(\frac{\text{yawing moment}}{qSb}\right)$

C_{n_β} rate of change of yawing-moment coefficient with angle of sideslip, per degree

C_{l_β} rate of change of rolling-moment coefficient with angle of sideslip, per degree

$C_{L_{\delta_e}}$ rate of change of lift coefficient with elevon deflection, measured at zero elevon deflection, per degree

$C_{l_{\delta_a}}$ rate of change of rolling-moment coefficient with elevon deflection, measured at zero elevon deflection, per degree

$C_{m_{\delta_e}}$ rate of change of pitching-moment coefficient with elevon deflection, measured at zero elevon deflection, per degree

$C_{c_{\delta_r}}$ rate of change of cross-wind-force coefficient with rudder deflection, measured at zero rudder deflection, per degree

$C_{n_{\delta_r}}$ rate of change of yawing-moment coefficient with rudder deflection, measured at zero rudder deflection, per degree

$\frac{dC_L}{d\alpha}$ slope of the lift curve measured at zero lift, per degree

$\frac{dC_m}{dC_L}$ slope of the pitching-moment curve measured at zero lift

$\frac{L}{D}$ lift-drag ratio

$\left(\frac{L}{D}\right)_{max}$ maximum lift-drag ratio

M free-stream Mach number

M_a first moment of area of control surface aft of hinge line, feet cubed

[redacted]

R	Reynolds number based on wing mean aerodynamic chord
S	total projected wing area, including area formed by extending leading and trailing edges to model plane of symmetry, square feet
Y	spanwise distance from plane of symmetry, feet
α	angle of attack of fuselage longitudinal axis, degrees
β	angle of sideslip of fuselage longitudinal axis, degrees
δ	angle of deflection of control surface (angle between wing chord or vertical-tail chord and control chord), measured in a plane perpendicular to the control-surface hinge line, degrees

Subscripts

e	combined inboard and outboard elevons
e_i	inboard elevon
e_o	outboard elevon
r	rudder
a	total differential elevon deflection, degrees

APPARATUS

Wind Tunnel and Equipment

This investigation was conducted in the Ames 6- by 6-foot supersonic wind tunnel. This wind tunnel is a closed-throat, variable-pressure wind tunnel in which the stagnation pressure and the Mach number can be continuously varied. The stagnation pressure can be varied from 2 to 17 pounds per square inch absolute and the Mach number can be varied from 0.60 to 0.90 and from 1.15 to 2.00. Further information regarding this wind tunnel is presented in reference 1.

The model was mounted on a sting having a diameter which was 64 percent of the diameter of the base of the model. The sting support system allowed the model angle of attack to be varied continuously from -12.5° to 22.5°.

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The aerodynamic forces and moments were measured by a four-component electrical strain-gage balance mounted in the body of the model. The balance is similar to that used in reference 2. The forces and moments were registered by recording-type galvanometers calibrated by applying known loads to the balance.

Model

A model of a high-speed fighter airplane (fig. 1) having a low-aspect-ratio, swept-back wing, swept-back vertical tail, and no horizontal tail was used in this investigation. Provisions were made for altering the plan form of the basic wing of the model by the addition of triangular wing tips. These extended tips had a constant section thickness of 4.5 percent. A three-view drawing of the basic-wing model and the model with the modified wing is shown in figure 2.

The basic wing had a modified trapezoidal plan form with a 52.5° leading-edge sweep angle and a taper ratio of 0.332. The modification consisted of rounding the wing tips to fair into the leading and trailing edges (see fig. 3). The wing was composed of symmetrical sections having a thickness of 7.0 percent of the chord (streamwise) at the wing root and tapering to 4.5 percent of the chord (streamwise) at the theoretical tip. (See table I for wing-section coordinates.) These sections were modified somewhat to fair into the trailing-edge elevons which were flat sided.

The movable control surfaces on the model consisted of constant-chord trailing-edge elevons, each divided into two spanwise segments, and a constant-percent-chord rudder (figs. 3 and 4). The control surfaces on one wing panel and the rudder were restrained by beams fitted with electrical strain gages for measuring the control hinge moments.

The model was fitted with inlets housed in wing-body fairings with internal ducts allowing the air to flow through and exhaust at the rear of the fuselage. In this investigation, the mass flow of air through the ducts was not adjustable; however, the ducts were constructed so that at supersonic speed the exit was choked, limiting the inlet Mach number to 0.4.

In order to accommodate the annular duct exit and the mounting sting, the boattailing on the model was somewhat less than would be expected on a full-scale airplane.

A conventional canopy was used on the model with a dorsal fin extending from the canopy to the leading edge of the vertical tail.

Provisions were made for testing the model without the vertical tail but with the dorsal fin faired into the body. Table II presents the coordinates for the vertical-tail sections.

TESTS AND PROCEDURE

The aerodynamic characteristics of both the basic-wing and modified-wing models were determined with control surfaces undeflected. Lift, drag, pitching-moment, and rolling-moment data were obtained through an angle-of-attack range of approximately -3° to $+12^\circ$ at Mach numbers of 0.60, 0.80, 0.90, 1.20, 1.35, and 1.70. Tests of both models were conducted at a constant Reynolds number of 2.0 million based on the mean aerodynamic chord of the basic wing (1.8 million based on the mean aerodynamic chord of the modified wing).[1] In the longitudinal stability phase of the investigation, the model was mounted with the wings vertical in the wind tunnel to utilize the most favorable stream conditions (reference 1).

The longitudinal control effectiveness of the elevons was investigated for the basic-wing configuration only. Tests of the model were conducted with the elevons on the right wing panel deflected. Increments of lift, drag, and pitching moment due to control deflection on the one wing panel were doubled and added to the corresponding values for the model with undeflected controls. In this manner pitching-moment and rolling-moment data were obtained simultaneously, thus reducing the number of tests required. The validity of this procedure was checked by testing the model through the speed range of the investigation with the elevons on both wing panels deflected. Results of these two methods were in excellent agreement. With the combined inboard and outboard elevons deflected through a range of 3° to -20°, lift, drag, pitching-moment, rolling-moment, and hinge-moment data were obtained for an angle-of-attack range of approximately -3° to 12° at Mach numbers of 0.60, 0.80, 0.90, 1.20, 1.35, and 1.70 and a constant Reynolds number of 3.2 million. Similar data were obtained at Mach numbers of 0.90 and 1.20 with the outboard control surface alone deflected through a range of 0° to 15°.

[1] The results of preliminary tests of the basic-wing model at Reynolds numbers of 1.0 to 4.0 million at supersonic speeds and 2.0 and 3.2 million at subsonic speeds indicate that, within this range, Reynolds number variation had no significant effect on the aerodynamic characteristics of the model with controls undeflected. The effects of Reynolds number variation on elevon and rudder effectiveness, however, were not investigated.

The lateral stability characteristics and rudder effectiveness of the basic-wing model were investigated with the elevons undeflected. The model was mounted with the wings horizontal in the tunnel, and the angle of sideslip was varied at preset angles of attack. With the rudder deflected through a range of 0° to 8°, cross-wind-force, yawing-moment, rolling-moment, and rudder hinge-moment data were obtained through an angle-of-sideslip range of 5° to -5° at -0.5°, 5.1°, and 10.5° angles of attack. Corresponding data were obtained under similar test conditions for the model with the vertical tail removed. The lateral stability and rudder effectiveness phase of the investigation was conducted at Mach numbers of 0.90 and 1.40 and at a constant Reynolds number of 3.2 million.

A tabulation of the test conditions is presented in table III.

Reduction of Data

The test data have been reduced to the standard NACA coefficient form based on the total projected wing area of the appropriate model configuration, including the area in the region formed by extending the leading and trailing edges to the plane of symmetry. Factors which could affect the accuracy of these results and the corrections applied are discussed in the following paragraphs.

Angles of attack and sideslip.- The determination of the actual angles of attack or sideslip of the model under load required that several corrections (determined from static calibrations) be applied to the nominal angle. Corrections of from 5 to 10 percent of the nominal angle were applied for the angular deflection of the sting and balance under aerodynamic load and for the angular movement due to structural clearances in the model support and balance.

Control-surface deflections.- A correction was applied to the nominal control-surface deflection angle for the deflection under load as determined from the static calibrations. The maximum correction amounted to about 3 percent of the nominal deflection angle. The results presented herein are for the corrected control deflection angles except in the figure showing variation of lateral stability characteristics with sideslip angle at various nominal rudder deflection angles.

Tunnel-wall interference.- Corrections to the data for the effects of the tunnel walls at subsonic speeds were made by the method of reference 3. The reflected bow wave did not intersect the model and so no corrections were made at supersonic Mach numbers. These corrections, which were added to the data, were as follows:

$$\Delta\alpha = 0.377\ C_L$$

$$\Delta C_D = 0.0066\ {C_L}^2$$

At subsonic speeds the effects of constriction of the flow due to the presence of the model were taken into account by the method of reference 4. This correction was calculated for conditions at zero angle of attack and was applied through the angle-of-attack range. At a Mach number of 0.90, this correction amounted to a 1-percent increase in Mach number and dynamic pressure over that determined from a calibration of the wind tunnel without a model in place.

Support interference.- The effects of support interference were believed to consist primarily of a change of pressure at the base of the model. A base-pressure correction was applied to adjust the pressure at the base of the model to free-stream static pressure. The base area used in this correction was the entire base area less the duct exit area. Drag values are, therefore, forebody drag coefficients. It was assumed, on the basis of information contained in reference 5, that the effect of sting-body interference on the forebody drag was negligible.

Stream variations.- Tests of the model were made at subsonic and supersonic speeds, in upright and inverted attitudes. Results of these tests showed no measurable effects of stream angle or stream curvature in the horizontal plane of the wind tunnel. Stream surveys conducted in the Ames 6- by 6-foot supersonic wind tunnel (reference 1) show some curvature in the vertical plane of the wind tunnel, but the results of a previous investigation (reference 6) indicate that this curvature had little effect on the longitudinal stability characteristics of the model when pitched in the horizontal plane. For the lateral stability tests, the model was mounted with its wings horizontal so that it yawed in the plane of least stream curvature. No attempt was made to determine the effects of the stream-angle variation in the vertical plane of the wind tunnel on the lateral directional data. The data obtained showed a small effect of stream angle on the rolling moment due to sideslip and no effect on the yawing moment due to sideslip.

Internal duct drag.- The model was equipped with twin ducts through which air could flow. However, provisions were not made to vary the mass flow, so a study of the duct drag characteristics was not feasible in this investigation. The drag data presented herein are for the complete model; that is, the drag due to flow through the ducts has not been subtracted from the final coefficients.

Precision of Data

The accuracy of the test results, excluding stream effects, is shown by the repeatability of the data in those cases where test conditions were duplicated in several tests. An interim of three months elapsed between tests during which the model and balance were disassembled. The effects of changes in clearance or alinement in the model and balance determine to a large extent the precision of these data. Examination of the results showed the data to be repeatable within the accuracy shown in the following table:

Quantity	Accuracy	
	$C_L = 0$	$C_L = 0.4$
C_D	±0.001	±0.002
C_L	±.003	±.005
C_m	±.001	±.001
C_l	±.0007	±.0017
C_n	±.001	±.001
C_c	±.003	±.005
C_h	±.008	±.013
M	±.03	±.03
R	$\pm.03 \times 10^6$	$\pm.03 \times 10^6$
α	±.10	±.15
δ	±.25	±.35

RESULTS AND DISCUSSION

All the results of the investigation are contained in table IV. Brief discussions are presented of the longitudinal stability characteristics, the longitudinal control effectiveness, and the lateral stability characteristics and rudder effectiveness in the following paragraphs. Typical data, pertinent to the discussion, are presented in the figures.

Longitudinal stability characteristics.— Lift coefficient as a function of angle of attack, and the variation of drag and pitching-moment coefficients with lift coefficient are presented in figure 5 for the basic-wing and modified-wing configurations with elevons undeflected at Mach numbers of 0.90, 1.20, and 1.70. Both configurations were longitudinally stable up to a lift coefficient of 0.5 throughout

the Mach number range of the investigation. The variation of pitching-moment coefficient with lift coefficient for the basic-wing model (fig. 5), although linear at 1.70 Mach number, exhibited a slight nonlinearity at 1.20 Mach number, and was markedly nonlinear at a Mach number of 0.90. The stability of the basic-wing model (dC_m/dC_L) increased from 0.04 at zero lift coefficient to 0.16 at a lift coefficient of 0.30 at a Mach number of 0.90. With the addition of triangular wing tips (modified wing), the stability remained nearly constant with increasing lift coefficient up to a lift coefficient of 0.30 at a Mach number of 0.90. Thus this increase in stability with increasing lift coefficient for the basic-wing model appears to be a plan form effect. This observation is substantiated by comparison of the results of an investigation of the pitching-moment characteristics of a plane triangular wing of aspect ratio 4 (reference 7) with the results of a later investigation (as yet unpublished) of the same wing with the tips cut off.

A summary of the aerodynamic characteristics of the two configurations, as a function of Mach number, is shown in figure 6. The difference in static margin at zero lift shown by the two plan forms of this investigation (fig. 6) decreased with increasing supersonic Mach numbers. It is evident from examination of figures 5 and 6 that the basic-wing model exhibited a greater change of stability with increasing lift coefficient at subsonic speeds and a greater change of stability (at zero lift) with Mach number than did the modified-wing model.

Longitudinal control effectiveness.- The longitudinal control effectiveness investigation was conducted for the basic-wing configuration with the control surfaces shown in figure 3. As noted previously, the control surfaces on only one wing panel were deflected and the increments of lift, drag, and pitching moment due to the control deflection were doubled.

The relationships of lift coefficients to angle of attack, control-surface deflection, and drag coefficient for the airplane balanced with the combined control surfaces and with the outboard elevons alone are shown in figure 7. These data indicate that, for the elevon deflection range of this investigation, the combined elevons would be capable of balancing the airplane (center of gravity at 0.25 $\bar{c}$) to a lift coefficient of 0.44 at a Mach number of 0.90, and to lift coefficients of 0.25 and 0.11 at Mach numbers of 1.20 and 1.70, respectively.

A limited study of the control characteristics with only the outboard elevons deflected shows that these elevons will balance the model to lift coefficients of 0.31 and 0.14 at Mach numbers of 0.90 and 1.20, respectively, but at the cost of considerably greater control deflections and consequently higher drag than with the combined control surfaces.

Examination of figure 7 reveals a decrease in the rate of change of balance lift coefficient with control deflection at 0.90 Mach number for both the combined elevons and the outboard elevons beginning at a lift coefficient of about 0.10. This apparent decrease in effectiveness coincides with the increase in stability with increasing lift coefficient discussed previously, and so appears to be the result of the inherent stability characteristics of the wing. Similar gradual decreases in control effectiveness at 1.20 and 1.70 Mach numbers are also presumed to be due to the increases in stability with lift coefficient. The variations with Mach number of elevon lift, pitching-moment, and rolling-moment effectiveness for the combined elevons deflected are presented in figure 8. It should be noted that the values of rolling-moment effectiveness shown are those for the elevon deflected on one wing only, while the lift and pitching-moment effectiveness values are for deflection of the elevon on both wings.

The stick-free stability of the airplane at 0.90 and 1.20 Mach numbers is illustrated in figure 9 for the combined elevons free and for only the outboard elevons free. The stick-fixed stability curves, for the model with elevons fixed at zero deflection, are also shown for comparison. It is of interest to note that for a Mach number of 0.90, the model exhibited a greater stability stick free than stick fixed, below a lift coefficient of 0.10. An explanation for this greater stability at low lift coefficients with the elevons free can be found in the tabulated hinge-moment data (table IV) which show that the elevons float downward with increasing angle of attack for angles of attack up to 8°. The stick-free neutral points for the model with the combined elevons free are located at 32 and 41 percent of the mean aerodynamic chord at Mach numbers of 0.90 and 1.20, respectively. With the inboard elevons fixed and outboard elevons free, the neutral points are at 33 and 42 percent of the mean aerodynamic chord at Mach numbers of 0.90 and 1.20, respectively.

Lateral stability characteristics and rudder effectiveness.– The variations of rolling-moment, yawing-moment, and cross-wind-force coefficients with sideslip angle for the basic-wing model with zero elevon deflection at 0.90 and 1.40 Mach number are shown in figure 10 for angles of attack of -0.5° and 5.1°. Also shown in figure 10 are data for an angle of attack of 10.5°, obtained at Mach numbers of 0.80 and 1.40. Since the data in figure 10 revealed nonlinearities in the variations of yawing-moment and rolling-moment coefficients with sideslip angle, the variations of lateral stability characteristics with angle of attack (fig. 11) are presented for both zero sideslip and a sideslip angle of 2°. Examination of figures 10 and 11 indicates that the model was directionally stable through the angle-of-attack and angle-of-sideslip ranges of the investigation and exhibited a positive dihedral effect at the positive angles of attack.

The effectiveness of the rudder in directionally controlling the model was investigated for the same range of test conditions as were the lateral stability characteristics of the model with controls undeflected. Cross-wind-force, yawing-moment, rolling-moment, and rudder-hinge-moment data were obtained at rudder deflections of 0° to 8° and with the vertical tail removed. Results of these tests, with the exception of rudder-hinge-moment data, are shown in figure 10 only for the model with 0° and 8° of rudder deflection since the variations of lateral stability characteristics with rudder deflection angle were found to be linear for the range of rudder deflections tested. The model was capable of maintaining sideslip angles of 3.6° and 2.3° at 0.90 and 1.40 Mach numbers, respectively, with the rudder deflected 8° at an angle of attack of −0.5°. The variation of rudder effectiveness with angle of attack is shown in figure 12.

The variation of elevon-rolling-moment effectiveness with sideslip angle was not investigated. However, a comparison of the maximum recorded rolling moment due to combined angles of attack and sideslip with the elevon-rolling-moment effectiveness obtained at zero sideslip provides some indication of the ability of the elevons to balance the model in roll at angles of sideslip. It will be noted, from the data presented in figure 10, that the maximum rolling moments obtained for the model with control surfaces undeflected occurred at an angle of sideslip of 5° and a nominal angle of attack of 5° for both 0.90 and 1.40 Mach numbers. By comparison of these values of rolling-moment coefficient with the data presented in table IV, for the elevon-rolling-moment effectiveness at zero sideslip angle, it is apparent that these rolling-moment coefficients are of approximately the same magnitude as those produced by a 9° total differential deflection of the combined elevons at 5° angle of attack at a Mach number of 0.90, and a 14° total differential elevon deflection at 5° angle of attack at a Mach number of 1.40.

CONCLUSIONS

A brief analysis of the results of this investigation indicated that the following observations are worthy of note:

1. Both the basic-wing (rounded wing tips) and the modified-wing (triangular wing tips) models with elevons undeflected were longitudinally stable, through the Mach number range for which data were obtained, to lift coefficients beyond those to which the elevons were capable of balancing the basic-wing model at the maximum elevon deflections considered.

2. The modified-wing model (triangular wing tips) exhibited a smaller change of stability with increasing lift coefficient and with increasing Mach number than did the basic-wing model.

3. At the maximum elevon deflection angles for which data were obtained, the combined elevons provided sufficient longitudinal control to balance the airplane to a lift coefficient of 0.44 at a Mach number of 0.90, and to lift coefficients of 0.25 and 0.11 at Mach numbers of 1.20 and 1.70, respectively. With only the outboard elevons deflected, the longitudinal control was somewhat less, but would be sufficient to balance the model to lift coefficients of 0.31 and 0.14 at Mach numbers of 0.90 and 1.20, respectively.

4. The basic-wing model was laterally and directionally stable through a nominal angle-of-attack range of 0° to 10° at Mach numbers of 0.90 and 1.40.

5. The model was capable of maintaining sideslip angles of 3.6° and 2.3° at Mach numbers of 0.90 and 1.40, respectively, with the rudder deflected 8° and at a –0.5° angle of attack.

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TABLE I.- WING SECTION COORDINATES

[Coordinates given in percent of local chord, measured parallel to plane of symmetry]

Wing-root section NACA 0007-63/30-9.5° mod.				Wing-tip section NACA 0004.5-63/30-6.6° mod.			
Station	Ordinate	Station	Ordinate	Station	Ordinate	Station	Ordinate
0	0	42.5	3.452	0	0	42.5	2.250
.1	.325	45.	3.421	.1	.209	45	
.2	.458	47.5	3.378	.2	.294	47.5	
.4	.643	50	3.324	.4	.413	50	
.6	.784	52.5	3.258	.6	.504	52.5	
.8	.901	55	3.178	.8	.579	55	
1.0	1.003	57.5	3.084	1	.645	57.5	
1.2	1.095	60	2.978	1.2	.704	60	
1.6	1.255	62.5	2.857	1.6	.807	62.5	2.234
2	1.394	65	2.723	2	.896	65	2.189
2.5	1.547	67.5	2.576	2.5	.994	67.5	2.122
3	1.681	70	2.417	3	1.081	70	2.034
4	1.914	72.5	2.247	4	1.230	72.5	1.930
5	2.110	75	2.067	5	1.356	75.	1.811
7.5	2.494	77.5	1.877	7.5	1.604	77.5	1.679
10	2.779	80	1.681	10	1.786	80	1.536
12.5	2.994	82.5	1.478	12.5	1.925	82.5	1.383
15.	3.158	85	1.272	15	2.030	85	1.220
17.5	3.281	87.5	1.065	17.5	2.109	87.5	1.048
20.	3.371	90	.858	20.	2.167	90	.869
22.5	3.433	92.5	.650	22.5	2.207	92.5	.683
25.	3.472	95	.443	25	2.232	95	.491
27.5	3.494	97.5	.236	27.5	2.246	97.5	.292
30	3.500	100	0	30.	2.250	100	0
32.5	3.499			32.5			
35	3.496			35			
37.5	3.489			37.5			
40	3.475			40			

L.E. radius: 0.539 percent chord T.E. radius: 0.032 percent chord	L.E. radius: 0.223 percent chord T.E. radius: 0.095 percent chord

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TABLE II.- VERTICAL TAIL SECTION COORDINATES

[Coordinates given in percent of local chord, measured parallel to the fuselage longitudinal axis]

Root section NACA 0008-63/30-9°		Tip section NACA 0006-63/30-6°45'	
Station	Ordinate	Station	Ordinate
0.1	0.371	0.1	0.279
.2	.523	.2	.392
.4	.735	.4	.551
.6	.895	.6	.672
.8	1.029	.8	.772
1.0	1.146	1.0	.860
2	1.593	2	1.195
3	1.922	3	1.441
4	2.187	4	1.641
5	2.411	5	1.808
10	3.176	10	2.382
15	3.609	15	2.707
20	3.852	20	2.889
25	3.969	25	2.976
30	4.000	30	3.000
35	3.981	35	2.992
40	3.916	40	2.960
50	3.800	45	2.893
55	3.627	50	2.784
60	3.399	55	2.630
65	3.118	60	2.431
70	2.790	65	2.192
H.L. 75	2.426	70	1.921
99.923	2.039	H.L. 75	1.631
100	.077	99.833	.167
	0	100	0
L.E. radius: 0.704 percent chord; rudder has flat sides T.E. radius: 0.077 percent chord		L.E. radius: 0.396 percent chord T.E. radius: 0.167 percent chord	

[redacted]

[redacted]

TABLE III.- TEST CONDITIONS

[B, basic model; Δ, triangular wing tip; e_i, inboard elevons; e_o, outboard elevon; V, vertical tail; r, rudder]

Test No.	Mach No.	Reynolds No. (million)	Configuration of model	δ_{e_i}	δ_{e_o}	δ_r
1	0.6	2.0	B	0	0	0
2	.8					
3	.9					
4	1.2					
5	1.35					
6	1.7					
7	.6	1.8	B+Δ			
8	.8					
9	.9					
10	1.2					
11	1.35					
12	1.7					
13	.6	3.2	B			
14	.8					
15	.9					
16	1.2					
17	1.35					
18	1.7					
19	.6			-20	-20	
20	.8					
21	.9					
22	1.2					
23	1.35					
24	1.7					
25	.6			-15	-15	
26	.8					
27	.9					
28	1.2					
29	1.35					
30	1.7					
31	.6			-8	-8	
32	.8					
33	.9					
34	1.2					
35	1.35					
36	1.7					
37	.6			-3	-3	
38	.8					
39	.9					
40	1.2					
41	1.35					
42	1.7					
43	.6			0	0	

NACA

[redacted]

TABLE III.- CONCLUDED

Test No.	Mach No.	Reynolds No. (million)	Configuration of model	δ_{e_i}	δ_{e_o}	δ_r
44	0.8	3.2	B	0	0	0
45	.9					
46	1.2					
47	1.35					
48	1.7					
49	.6			3	3	
50	.8					
51	.9					
52	1.2					
53	1.35					
54	1.7					
55	.9			0	-15	
56	1.2				-15	
57	.9				-8	
58	1.2				-8	
59	.9				-3	
60	1.2				-3	
61	.9				0	
62	1.4					
63	.9					2
64	1.4					2
65	.9					4
66	1.4					4
67	.9					6
68	1.4					6
69	.9					8
70	1.4					8
71	.9		B-V			--
72	1.4		B-V			--
73	.9		B			0
74	1.4					0
75	.9					4
76	1.4					4
77	.9					8
78	1.4					8
79	.9		B-V			--
80	1.4		B-V			--
81	.8		B			0
82	1.4					0
83	.8					4
84	1.4					4
85	.8					8
86	1.4					8
87	.8		B-V			--
88	1.4		B-V			--

NACA

[redacted]

TABLE IV.- AERODYNAMIC CHARACTERISTICS OF A MODEL OF A HIGH-SPEED, TAILLESS FIGHTER AIRPLANE

(a) Tests 1 through 9

Test No.	α	C_L	C_D	C_m	C_l	L/D	Test No.	α	C_L	C_D	C_m	C_l	L/D	Test No.	α	C_L	C_D	C_m	C_l	L/D
1	-3.17	-0.146	0.0139	0.004	-0.0015	-----	4	-3.18	-0.180	0.0452	0.038	-0.0001	----	7	-3.23	-0.203	0.0157	0.0313	-0.0024	-----
	-1.07	-.049	.0097	0	-.0012	-----		-1.07	-.062	.0370	.015	-.0008	----		-1.08	-.074	.0104	.0122	-.0028	-----
	-.53	-.027	.0093	0	-.0013	-----		-.53	-.032	.0363	.009	-.0003	----		-.53	-.040	.0097	.0078	-.0029	-----
	.52	.025	.0090	-.003	-.0010	2.78		.54	.029	.0360	-.002	-.0002	0.80		.53	.031	.0090	-.0051	-.0027	3.44
	1.06	.045	.0092	-.004	-.0012	4.89		1.06	.051	.0365	-.006	-.0004	1.40		1.05	.054	.0094	-.0085	-.0028	5.75
	2.12	.096	.0107	-.006	-.0012	8.97		2.13	.112	.0389	-.017	-.0006	2.88		2.14	.128	.0109	-.0208	-.0025	11.75
	4.23	.199	.0171	-.012	-.0012	11.64		4.24	.240	.0497	-.043	-.0008	4.83		4.30	.265	.0225	-.0402	-.0019	11.77
	6.35	.316	.0304	-.022	-.0015	10.40		6.33	.367	.0707	-.072	-.0006	5.19		6.43	.396	.0371	-.0536	-.0015	10.67
	8.48	.440	.0554	-.034	-.0013	7.94		8.42	.488	.1006	-.100	-.0003	4.85		8.54	.509	.0622	-.0624	-.0012	8.18
	10.59	.556	.0907	-.046	-.0012	6.13		10.50	.594	.1370	-.121	-.0017	4.34		10.69	.639	.1048	-.0647	-.0009	6.10
	12.70	.656	.1322	-.054	-.0012	4.96		12.59	.671	.1730	-.130	-.0020	3.88		12.80	.742	.1518	-.0640	-.0013	4.89
2	-3.16	-.162	.0154	.006	-.0014	-----	5	-3.17	-.159	.0452	.035	-.0005	----	8	-3.28	-.224	.0178	.0374	-.0020	-----
	-1.06	-.055	.0103	0	-.0012	-----		-1.05	-.052	.0374	.013	-.0009	----		-1.10	-.080	.0104	.0143	-.0027	-----
	-.53	-.031	.0098	0	-.0011	-----		-.35	-.026	.0366	.008	-.0010	----		-.55	-.046	.0095	.0092	-.0027	-----
	.53	.025	.0092	-.002	-.0009	2.72		.54	.030	.0367	-.004	-.0013	.82		.54	.032	.0092	-.0057	-.0029	3.48
	1.04	.043	.0097	-.003	-.0009	4.43		1.05	.049	.0371	-.007	-.0013	1.32		1.08	.058	.0099	-.0098	-.0027	5.86
	2.11	.099	.0115	-.006	-.0013	8.61		2.11	.107	.0395	-.020	-.0015	2.71		2.17	.137	.0120	-.0247	-.0022	11.42
	4.21	.216	.0190	-.014	-.0014	11.37		4.21	.217	.0501	-.045	-.0016	4.33		4.35	.289	.0239	-.0467	-.0018	12.10
	6.31	.341	.0378	-.026	-.0015	9.02		6.30	.332	.0695	-.073	-.0013	4.78		6.51	.426	.0456	-.0584	-.0018	9.35
	8.40	.462	.0673	-.039	-.0009	6.86		8.38	.443	.0973	-.100	-.0010	4.55		8.65	.552	.0796	-.0748	-.0010	6.94
	10.49	.580	.1086	-.055	-.0006	5.34		10.46	.544	.1312	-.124	-.0005	4.14		10.79	.667	.1241	-.0902	-.0007	5.38
	12.56	.666	.1524	-.062	-.0006	4.37		12.53	.634	.1704	-.145	-.0006	3.72		12.90	.736	.1686	-.0737	-.0010	4.36
3	-3.27	-.182	.0172	.009	-.0015	-----	6	-3.13	-.130	.0426	.029	-.0003	----	9	-3.14	-.256	.0201	.0488	-.0020	-----
	-1.09	-.062	.0109	.001	-.0013	-----		-1.05	-.044	.0358	.008	-.0008	----		-.93	-.094	.0108	.0191	-.0025	-----
	-.56	-.034	.0098	0	-.0012	-----		-.53	-.021	.0355	.003	-.0009	----		-.56	-.056	.0100	.0131	-.0026	-----
	.54	.024	.0091	-.001	-.0010	2.64		.35	.025	.0353	-.008	-.0011	.71		.54	.033	.0096	-.0057	-.0027	3.44
	2.15	.107	.0122	-.005	-.0014	8.78		1.04	.041	.0356	-.011	-.0012	1.15		1.07	.061	.0103	-.0111	-.0023	5.72
	4.34	.240	.0221	-.017	-.0016	10.86		2.08	.087	.0377	-.022	-.0016	2.31		2.21	.155	.0136	-.0305	-.0025	11.40
	6.50	.387	.0461	-.040	-.0013	8.40		4.17	.177	.0464	-.043	-.0021	3.82		4.39	.314	.0271	-.0559	-.0018	11.58
	8.63	.490	.0781	-.049	-.0005	6.28		6.24	.263	.0615	-.064	-.0024	4.28		6.57	.464	.0551	-.0750	-.0019	8.42
	10.72	.549	.1140	-.047	-.0014	4.81		8.31	.347	.0825	-.084	-.0028	4.21		8.71	.572	.0902	-.0799	.0009	6.34
								10.37	.428	.1089	-.104	-.0032	3.93							
								12.44	.508	.1414	-.124	-.0036	3.59							

TABLE IV.- CONTINUED

(b) Tests 10 through 18

Test No.	α	C_L	C_D	C_m	C_l	L/D
10	-2.98	-0.218	0.0435	0.0665	-0.0017	-----
	-.88	-.074	.0338	.0242	-.0016	-----
	-.34	-.036	.0328	.0127	-.0014	-----
	.53	.032	.0329	-.0053	-.0011	0.97
	1.06	.059	.0338	-.0129	-.0018	1.74
	1.95	.134	.0362	-.0336	-.0013	3.70
	4.03	.279	.0485	-.0743	-.0004	5.76
	6.12	.421	.0711	-.1117	-.0002	5.92
	8.20	.553	.1028	-.1452	.0007	5.38
	10.30	.658	.1401	-.1635	.0005	4.69
11	-2.97	-.187	.0433	.0551	-.0013	-----
	-.87	-.061	.0345	.0193	-.0016	-----
	-.34	-.029	.0335	.0105	-.0014	-----
	.53	.032	.0334	-.0059	-.0015	.96
	1.06	.056	.0340	-.0126	-.0015	1.65
	1.94	.121	.0365	-.0308	-.0013	3.32
	4.02	.246	.0477	-.0654	-.0009	5.16
	6.10	.367	.0680	-.0986	-.0007	5.40
	8.17	.481	.0958	-.1284	-.0003	5.02
	10.24	.582	.1298	-.1530	-.0002	4.48
	12.32	.675	.1697	-.1739	-.0001	3.98
12	-2.96	-.140	.0420	.0313	-.0001	-----
	-1.04	-.045	.0354	.0096	-.0010	-----
	-.52	-.020	.0347	.0034	-.0012	-----
	.35	.026	.0344	-.0077	-.0014	.76
	.86	.042	.0343	-.0118	-.0016	1.22
	1.91	.092	.0366	-.0248	-.0021	2.51
	3.99	.188	.0450	-.0510	-.0029	4.18
	6.04	.279	.0604	-.0750	-.0035	4.62
	8.11	.366	.0813	-.0981	-.0042	4.50
	10.16	.443	.1065	-.1186	-.0046	4.16
	12.22	.526	.1393	-.1403	-.0048	3.78
13	-.53	-.018	.0107	-.0019	-.0012	-----
	-1.08	-.043	.0111	-.0011	-.0013	-----
	-3.25	-.146	.0152	.0042	-.0014	-----
	-6.49	-.316	.0330	.0177	-.0016	-----
	.53	.022	.0105	-.0028	-.0011	2.10

Test No.	α	C_L	C_D	C_m	C_l	L/D
13	1.08	0.048	0.0107	-0.0043	-0.0010	4.49
	2.16	.099	.0122	-.0066	-.0008	8.12
	4.33	.207	.0182	-.0133	-.0007	11.39
	6.49	.319	.0322	-.0227	0	9.91
	8.65	.440	.0563	-.0339	.0004	7.81
	10.83	.566	.0938	-.0478	.0007	6.03
	12.99	.679	.1396	-.0567	-----	4.86
	15.10	.747	.1870	-.0585	-.0004	3.99
	17.22	.821	.2456	-.0669	-.0002	3.34
	19.30	.871	.3008	-.0736	-----	2.90
	21.33	.898	.3511	-.0879	-----	2.56
14	-.55	-.021	.0111	-.0015	-.0010	-----
	-1.10	-.047	.0115	-.0008	-.0010	-----
	-3.32	-.162	------	.0060	-.0014	-----
	-6.64	-.359	.0412	.0242	-.0010	-----
	.54	.022	.0109	-.0029	-.0007	2.02
	1.10	.049	.0114	-.0039	-.0007	4.31
	2.21	.106	.0129	-.0074	-.0008	8.19
	4.42	.224	.0207	-.0153	-.0005	10.84
	6.63	.355	.0401	-.0271	.0004	8.84
	8.83	.485	.0728	-.0424	0	6.66
	11.02	.600	.1159	-.0558	-.0002	5.18
	13.16	.677	.1598	-.0595	-----	4.84
	15.27	.741	.2070	-.0672	.0001	3.58
15	-.56	-.025	.0111	-.0006	-.0011	-----
	-1.05	-----	.0107	-----	-.0012	-----
	-3.37	-.184	.0185	.0107	-.0014	-----
	-6.74	-.415	.0517	.0440	-.0002	-----
	.82	.035	.0110	-.0023	-.0008	3.18
	1.11	.051	.0115	-.0029	-.0008	4.43
	2.24	.113	.0135	-.0069	-.0010	8.35
	4.47	.249	.0240	-.0197	-.0009	10.38
	6.72	.406	.0499	-.0429	.0003	8.14
	8.90	.505	.0836	-.0511	.0013	6.04
16	-.42	-.019	.0352	.0062	-.0001	-----
	-1.08	-.053	.0364	.0125	0	-----
	-3.26	-.178	.0447	.0365	.0001	-----

Test No.	α	C_L	C_D	C_m	C_l	L/D
16	-6.51	-0.383	0.0740	0.0821	0.0002	-----
	.55	.024	.0357	-.0015	-.0003	0.67
	1.10	.054	.0356	-.0069	-.0002	1.52
	2.20	.116	.0377	-.0182	-.0003	3.07
	4.37	.245	.0492	-.0444	-.0006	4.98
	6.54	.380	.0715	-.0750	-.0002	5.32
	8.69	.509	.1037	-.1038	.0008	4.91
	10.84	.620	.1426	-.1268	.0010	4.35
	12.98	.701	.1820	-.1333	.0062	3.85
17	-.40	-.013	.0359	.0052	-.0008	-----
	-1.07	-.044	.0367	.0118	-.0008	-----
	-3.24	-.158	.0448	.0353	-.0007	-----
	-6.46	-.337	.0715	.0768	-.0003	-----
	.56	.027	.0358	-.0029	-.0009	.75
	1.10	.054	.0365	-.0083	-.0012	1.48
	2.20	.112	.0389	-.0205	-.0013	2.88
	4.34	.225	.0498	-.0461	-.0012	4.52
	6.48	.343	.0700	-.0752	-.0007	4.90
	8.62	.453	.0981	-.1013	0	4.62
	10.76	.555	.1330	-.1256	.0005	4.17
	12.89	.649	.1742	-.1466	.0008	3.72
	14.81	.726	.2165	-.1646	.0010	3.35
18	-.52	-.010	.0369	.0005	-.0009	-----
	-1.06	-.035	.0374	.0060	-.0007	-----
	-3.21	-.127	.0437	.0277	-.0002	-----
	-6.38	-.266	.0653	.0605	.0004	-----
	.53	.021	.0361	-.0074	-.0010	.58
	1.07	.045	.0366	-.0129	-.0011	1.23
	2.15	.092	.0389	-.0238	-.0013	2.37
	4.26	.181	.0481	-.0445	-.0017	3.76
	6.37	.269	.0633	-.0656	-.0020	4.25
	8.48	.362	.0865	-.0880	-.0022	4.18
	10.59	.444	.1141	-.1084	-.0025	3.89
	12.70	.521	.1468	-.1272	-.0025	3.55
	14.79	.589	.1835	-.1443	-.0029	3.21
	16.90	.659	.2266	-.1624	-.0029	2.91
	18.07	.699	.2528	-.1724	-.0026	2.76

TABLE IV.- CONTINUED

(c) Tests 19 through 27

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
19	2.09	-0.001	0.0181	0.0453	0.0200	-19.66	-19.66	0.2415	0.1654
	4.27	.107	.0206	.0366	.0199	-19.68	-19.66	.2250	.1620
	6.44	.220	.0289	.0264	.0201	-19.70	-19.68	.2115	.1518
	8.60	.345	.0512	.0119	.0197	-19.72	-19.72	.1944	.1364
	10.77	.465	.0834	-.0005	.0196	-19.73	-19.83	.1898	.0809
	12.93	.582	.1258	-.0141	.0222	-19.74	-19.96	.1839	.0193
	15.06	.661	.1718	-.0161	.0196	-19.82	-19.98	.1255	.0117
	17.17	.733	.2259	-.0262	.0195	-19.90	-19.95	.0717	.0219
	19.26	.789	.2772	-.0344	.0193	-19.96	-19.93	.0253	.0320
	21.29	.821	.3278	-.0497	.0182	-20.00	-19.93	-.0059	.0328
20	2.14	.016	.0192	.0420	.0174	-19.52	-19.48	.2704	.1983
	4.38	.136	.0234	.0329	.0172	-19.55	-19.49	.2527	.1956
	6.59	.267	.0377	.0185	.0169	-19.58	-19.55	.2325	.1716
	8.80	.397	.0865	.0003	.0149	-19.59	-19.67	.2266	.1263
	10.99	.518	.1054	-.0146	.0140	-19.58	-19.88	.2336	.0471
	13.15	.609	.1498	-.0234	.0150	-19.66	-19.90	.1922	.0398
	15.26	.673	.1973	-.0315	.0135	-19.73	-19.83	.1525	.0659
	17.36	.730	.2468	-.0409	.0122	-19.79	-19.79	.1170	.0792
	19.46	.787	.3019	-.0530	.0110	-19.83	-19.75	.0921	.0959
21	2.18	.028	.0213	.0433	.0165	-19.44	-19.36	.2901	.2232
	4.45	.163	.0276	.0300	.0158	-19.48	-19.37	.2662	.2219
	6.70	.313	.0466	.0083	.0139	-19.52	-19.42	.2454	.2022
	8.91	.450	.0826	-.0182	.0104	-19.49	-19.74	.2624	.0924
	11.06	.532	.1217	-.0265	.0069	-19.55	-19.84	.2287	.0553
	13.23	.629	.1702	-.0395	.0087	-19.57	-19.74	.2176	.0904
22	2.23	.077	.0456	.0144	.0136	-19.21	-18.80	.3487	.3635
	4.39	.198	.0553	-.0104	.0132	-19.26	-18.81	.3260	.3590
	6.56	.335	.0753	-.0418	.0132	-19.28	-18.92	.3165	.3222
	8.72	.465	.1049	-.0728	.0131	-19.27	-19.29	.3223	.2118
	10.87	.579	.1420	-.0973	.0122	-19.29	-19.56	.3116	.1314
23	2.22	.079	.0470	.0071	.0104	-19.25	-18.77	.3236	.3581
	4.36	.190	.0563	-.0187	.0104	-19.29	-18.82	.3054	.3441
23	6.50	0.304	0.0737	-0.0467	0.0106	-19.31	-19.04	0.2959	0.2798
	8.64	.415	.0996	-.0744	.0105	-19.35	-19.28	.2778	.2073
	10.77	.521	.1324	-.1004	.0103	-19.40	-19.64	.2559	.1025
24	2.16	.067	.0453	-.0030	.0074	-19.32	-18.93	.2767	.2982
	4.29	.161	.0535	-.0260	.0068	-19.37	-19.12	.2582	.2447
	6.40	.244	.0664	-.0459	.0062	-19.40	-19.36	.2420	.1771
	8.51	.328	.0857	-.0666	.0057	-19.49	-19.58	.2072	.1153
	10.62	.410	.1113	-.0868	.0053	-19.60	-19.70	.1608	.0825
25	1.03	-.025	.0148	.0378	.0160	-14.79	-14.76	.1496	.1176
	2.10	.019	.0146	.0347	.0158	-14.80	-14.76	.1436	.1167
	4.28	.128	.0181	.0275	.0160	-14.81	-14.77	.1345	.1107
	6.45	.239	.0287	.0179	.0163	-14.82	-14.78	.1255	.1064
	8.60	.357	.0483	.0049	.0165	-14.84	-14.82	.1119	.0886
	10.77	.484	.0827	-.0100	.0164	-14.84	-14.94	.1103	.0297
	12.94	.500	.1261	-.0221	.0192	-14.85	-15.04	.1042	-.0187
	15.06	.673	.1716	-.0232	.0147	-14.91	-15.06	.0619	-.0272
	17.17	.754	.2283	-.0354	.0157	-14.97	-15.05	.0181	-.0246
	19.26	.805	.2807	-.0420	.0150	-15.02	-15.05	-.0211	-.0246
26	1.06	-.016	.0159	.0376	.0146	-14.67	-14.65	.1900	.1364
	2.15	.032	.0163	.0339	.0143	-14.69	-14.65	.1791	.1364
	4.38	.151	.0210	.0249	.0142	-14.71	-14.66	.1658	.1343
	6.58	.280	.0359	.0108	-.0144	-14.73	-14.69	.1525	.1221
	8.79	.414	.0659	-.0064	.0134	-14.74	-14.80	.1487	.0783
	10.97	.528	.1054	-.0206	.0133	-14.73	-14.95	.1534	.0197
	13.13	.611	.1493	-.0250	.0137	-14.79	-14.92	.1207	.0306
	15.25	.677	.1962	-.0324	.0143	-14.86	-14.84	.0794	.0617
	17.34	.732	.2453	-.0414	.0136	-14.90	-14.77	.0541	.0902
27	1.08	-.010	.0176	.0389	.0134	-14.59	-14.56	.2169	.1614
	2.19	.045	.0180	.0338	.0130	-14.61	-14.56	.2053	.1584
	4.45	.183	.0257	.0203	.0124	-14.64	-14.55	.1896	.1640
	6.69	.332	.0451	-.0015	.0116	-14.67	-14.58	.1716	.1532
	8.88	.455	.0809	-.0212	.0100	-14.63	-14.83	.1954	.0585

TABLE IV.- CONTINUED

(d) Tests 28 through 36

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
28	1.11	0.023	0.0410	0.0193	0.0110	-14.38	-13.92	0.2821	0.3358
	2.22	.086	.0429	.0068	.0105	-14.42	-13.97	.2648	.3222
	4.38	.211	.0527	-.0182	.0101	-14.48	-14.03	.2388	.3005
	6.54	.348	.0736	-.0498	.0102	-14.50	-14.13	.2259	.2702
	8.70	.477	.1041	-.0800	.0105	-14.52	-14.43	.2198	.1760
	10.84	.590	.1417	-.1040	.0098	-14.54	-14.70	.2069	.0919
29	1.11	.030	.0418	.0126	.0079	-14.42	-13.96	.2558	.3106
	2.20	.085	.0440	.0010	.0075	-14.44	-13.97	.2434	.3070
	4.35	.199	.0538	-.0250	.0076	-14.50	-14.04	.2190	.2847
	6.49	.315	.0720	-.0535	.0078	-14.54	-14.23	.2002	.2293
	8.62	.427	.0989	-.0814	.0078	-14.59	-14.47	.1788	.1560
30	1.08	.027	.0410	.0027	.0055	-14.50	-14.17	.2163	.2459
	2.15	.072	.0429	-.0075	.0052	-14.52	-14.22	.2077	.2310
	4.27	.161	.0510	-.0288	.0047	-14.57	-14.35	.1848	.1923
	6.37	.247	.0645	-.0496	.0042	-14.62	-14.52	.1620	.1402
	8.48	.332	.0840	-.0704	.0038	-14.69	-14.73	.1301	.0799
31	.52	-.011	.0124	.0192	.0081	-7.90	-7.90	.0705	.0507
	1.05	.006	.0123	.0188	.0082	-7.90	-7.89	.0706	.0516
	2.14	.059	.0132	.0155	.0082	-7.90	-7.89	.0675	.0532
	4.31	.164	.0182	.0086	.0083	-7.91	-7.89	.0631	.0516
	6.46	.272	.0292	-.0004	.0088	-7.92	-7.90	.0555	.0465
	8.63	.397	.0518	-.0132	.0094	-7.93	-7.93	.0495	.0347
	10.80	.522	.0874	-.0270	.0095	-7.93	-8.04	.0451	.0211
	12.96	.632	.1307	-.0372	.0125	-7.95	-8.12	.0359	-.0607
	15.09	.707	.1775	-.0401	.0088	-7.99	-8.15	.0044	-.0741
	17.20	.780	.2333	-.0485	.0089	-8.04	-8.16	-.0314	-.0768
	19.28	.833	.2878	-.0559	.0087	-8.09	-8.16	-.0689	-.0777
	21.31	.862	.3778	-.0714	.0085	-8.13	-8.17	-.0944	-.0810
32	.53	-.009	.0124	.0213	.0082	-7.86	-7.84	.0797	.0603
	1.07	.009	.0125	.0206	.0082	-7.85	-7.84	.0808	.0610
	2.19	.066	.0135	.0167	.0080	-7.86	-7.84	.0760	.0609
32	4.40	0.184	0.0203	0.0080	0.0080	-7.87	-7.85	0.0715	0.0564
	6.60	.308	.0368	-.0037	.0090	-7.88	-7.88	.0640	.0449
	8.81	.441	.0678	-.0205	.0087	-7.90	-7.96	.0552	.0155
	10.99	.549	.1086	-.0328	.0093	-7.91	-8.11	.0481	-.0433
	13.14	.632	.1497	-.0370	.0113	-7.98	-8.11	.0095	-.0419
	15.26	.697	.1977	-.0447	.0100	-8.03	-8.08	-.0226	-.0330
	17.36	.753	.2482	-.0537	.0093	-8.07	-8.06	-.0451	-.0248
33	.54	-.009	.0130	.0234	.0076	-7.81	-7.77	.0940	.0792
	1.09	.013	.0132	.0221	.0075	-7.82	-7.77	.0929	.0804
	2.23	.077	.0146	.0170	.0072	-7.83	-7.77	.0863	.0802
	4.48	.208	.0233	.0050	.0072	-7.93	-7.78	------	.0764
	6.72	.360	.0452	-.0169	.0079	-7.84	-7.83	.0806	.0575
	8.92	.469	.0817	-.0291	.0082	-7.81	-7.90	.0945	.0339
	11.01	.543	.1208	-.0544	.0061	-7.83	-7.71	.0860	.1023
34	.56	.012	.0375	.0116	.0055	-7.66	-7.32	.1524	.2062
	1.12	.042	.0375	.0058	.0052	-7.67	-7.34	.1444	.1991
	2.22	.100	.0395	-.0050	.0052	-7.70	-7.38	.1310	.1872
	4.38	.229	.0495	-.0313	.0048	-7.76	-7.46	.1044	.1628
	6.55	.366	.0704	-.0622	.0051	-7.81	-7.54	.0828	.1374
35	.57	.018	.0378	.0076	.0035	-7.66	-7.41	.1429	.1701
	1.12	.044	.0386	.0023	.0033	-7.68	-7.42	.1353	.1660
	2.21	.097	.0404	-.0088	.0031	-7.71	-7.44	.1206	.1603
	4.35	.209	.0503	-.0346	.0031	-7.78	-7.50	.0922	.1424
	6.50	.331	.0692	-.0644	.0035	-7.84	-7.65	.0671	.0996
36	.54	.015	.0378	.0001	.0024	-7.72	-7.53	.1172	.1336
	1.08	.037	.0380	-.0049	.0022	-7.73	-7.55	.1116	.1282
	2.15	.082	.0398	-.0154	.0020	-7.76	-7.60	.0989	.1135
	4.27	.170	.0480	-.0360	.0016	-7.82	-7.72	.0715	.0787
	6.38	.257	.0650	-.0570	.0011	-7.88	-7.87	.0469	.0377

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TABLE IV.- CONTINUED

(e) Tests 37 through 45

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
37	-0.54	-0.032	0.0110	0.0071	0.0025	-2.96	-2.96	0.0276	0.0207
	.53	.009	.0106	.0060	.0024	-2.96	-2.96	.0276	.0216
	1.07	.033	.0110	.0047	.0024	-2.96	-2.95	.0276	.0225
	2.15	.083	.0122	.0030	.0024	-2.96	-2.95	.0260	.0242
	4.32	.189	.0177	-.0045	.0027	-2.96	-2.95	.0229	.0225
	6.47	.300	.0305	-.0130	.0033	-2.97	-2.96	.0199	.0190
	8.64	.425	.0540	-.0258	.0039	-2.97	-2.98	.0153	.0086
	10.81	.549	.0907	-.0388	.0041	-2.98	-3.09	.0106	-.0449
	12.96	.655	.1341	-.0476	.0069	-3.00	-3.17	0	-.0855
	15.08	.731	.1821	-.0512	.0026	-3.03	-3.21	-.0290	-.1028
	17.20	.805	.2390	-.0596	.0029	-3.08	-3.21	-.0657	-.1059
	19.28	.856	.2944	-.0675	.0029	-3.14	-3.21	-.1039	-.1051
	21.31	.885	.3451	-.0818	.0029	-3.17	-3.22	-.1314	-.1094
38	-.55	-.034	.0114	.0081	.0026	-2.95	-2.95	.0282	.0186
	.54	.010	.0108	.0069	.0025	-2.94	-2.95	.0306	.0207
	1.09	.036	.0113	.0060	.0027	-2.94	-2.94	.0318	.0227
	2.20	.091	.0129	.0026	.0024	-2.95	-2.94	.0294	.0234
	4.40	.206	.0197	-.0057	.0024	-2.95	-2.94	.0269	.0220
	6.61	.337	.0384	-.0178	.0034	-2.95	-2.96	.0256	.0165
	8.82	.470	.0705	-.0340	.0032	-2.97	-3.03	.0158	-.0130
	11.00	.581	.1122	-.0466	.0028	-2.98	-3.17	.0084	-.0678
	13.15	.660	.1558	-.0507	.0054	-3.06	-3.21	-.0352	-.0835
	15.25	.721	.2152	-.0592	.0037	-3.12	-3.22	-.0708	-.0861
	17.35	.775	.2658	-.0669	.0034	-3.16	-3.23	-.0979	-.0910
39	-.56	-.039	.0115	.0106	.0025	-2.94	-2.96	.0282	.0159
	.54	.007	.0110	.0099	.0026	-2.93	-2.95	.0339	.0191
	1.10	.037	.0115	.0079	.0025	-2.93	-2.94	.0339	.0216
	2.23	.098	.0134	.0034	.0023	-2.93	-2.94	.0339	.0229
	4.46	.229	.0225	-.0083	.0023	-2.93	-2.94	.0338	.0209
	6.71	.385	.0473	-.0316	.0035	-2.92	-3.00	.0382	.0012
	8.89	.488	.0813	-.0411	.0044	-2.95	-3.13	.0258	.0487
40	-.41	-.025	.0359	.0117	.0021	-2.84	-2.68	.0723	.0965
	.56	.022	.0357	.0035	.0020	-2.86	-2.70	.0616	.0903
	1.10	.047	.0360	-.0010	.0018	-2.87	-2.72	.0558	.0853
40	2.21	0.108	0.0380	-0.0122	0.0016	-2.90	-2.75	0.0415	0.0750
	4.37	.238	.0490	-.0386	.0014	-2.96	-2.82	.0151	.0543
41	-.40	-.018	.0366	.0100	.0010	-2.84	-2.73	.0706	.0817
	.56	.025	.0366	.0014	.0008	-2.87	-2.75	.0575	.0752
	1.10	.048	.0370	-.0032	.0006	-2.88	-2.76	.0509	.0725
	2.20	.105	.0757	-.0152	.0004	-2.92	-2.78	.0351	.0650
	4.34	.222	.0500	-.0417	.0004	-2.98	-2.83	.0046	.0498
42	-.52	-.012	.0369	.0033	.0003	-2.87	-2.78	.0542	.0652
	.53	.018	.0365	-.0038	.0002	-2.89	-2.80	.0450	.0583
	1.07	.040	.0368	-.0090	.0002	-2.91	-2.82	.0386	.0527
	2.15	.087	.0390	-.0199	-.0001	-2.94	-2.87	.0241	.0363
	4.26	.175	.0479	-.0405	-.0005	-3.00	-2.99	0	.0025
43	-3.26	-.146	.0151	.0037	-.0019	-----	-.01	-----	-.0058
	-1.08	-.042	.0113	-.0014	-.0016	-----	0	-----	-.0008
	-.54	-.017	.0107	-.0025	-.0014	-----	0	-----	.0008
	.54	.025	.0106	-.0036	-.0014	-----	0	-----	.0024
	1.08	.052	.0110	-.0050	-.0014	-----	.01	-----	.0041
	2.17	.103	.0122	-.0071	-.0015	-----	.01	-----	.0050
44	-3.33	-.162	.0166	.0054	-.0018	0	-.02	-.0035	-.0080
	-1.10	-.047	.0114	-.0013	-.0016	0	0	-.0023	-.0019
	-.55	-.021	.0109	-.0020	-.0014	0	0	-.0011	.0006
	.54	.026	.0108	-.0044	-.0015	-----	.01	-----	.0033
	1.10	.052	.0111	-.0050	-.0015	-----	.01	-----	.0053
	2.22	.111	.0130	-.0081	-.0015	-----	.02	-----	.0080
45	-3.38	-.188	-.0188	.0122	-.0020	-.02	-.03	-.0142	-.0123
	-1.13	-.055	-.0118	.0003	-.0017	-.01	-.01	-.0087	-.0043
	-.56	-.025	-.0110	-.0011	-.0016	-.01	0	-.0054	-.0012
	.55	.023	.0110	-.0024	-.0015	-----	----	-----	.0043
	1.11	.053	.0115	-.0039	-.0015	-----	----	.0010	.0074
	2.25	.118	.0137	-.0082	-.0017	-----	----	.0032	.0117

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TABLE IV.- CONTINUED
(f) Tests 46 through 54

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
46	-3.27	-0.179	0.0448	0.0364	-0.0003	0.08	0.09	0.0405	0.0286
	-1.08	-.052	.0367	.0119	-.0005	.02	.03	.0122	.0899
	-.53	-.020	.0359	.0062	-.0004	.01	.02	.0056	.0635
	.55	.024	.0355	-.0013	-.0004	0	.01	-.0009	.0367
	1.11	.054	.0359	-.0065	-.0005	-.01	0	-.0056	.0156
	2.21	.118	.0380	-.0182	-.0006	-.04	-.02	-.0187	-.0068
47	-3.24	-.157	.0447	.0345	-.0013	.10	.09	.0455	.0256
	-1.07	-.043	.0370	.0111	.0032	.03	.02	.0163	.0061
	-.40	-.011	.0362	.0051	-.0012	.01	0	.0081	.0015
	.56	.027	.0362	-.0026	-.0012	0	0	-----	-.0015
	1.10	.054	.0367	-.0079	-.0014	-.01	-.02	-.0054	-.0045
	2.20	.113	.0391	-.0203	-.0016	-.05	-.04	-.0225	-.0112
48	-3.20	-.126	.0432	.0272	-.0006	.09	.11	.0393	.0323
	-1.06	-.034	.0372	.0059	-.0011	.02	.03	.0116	.0096
	-.52	-.010	.0366	.0003	-.0012	.01	.02	.0053	.0050
	.53	.022	.0363	-.0071	-.0012	0	0	-.0009	-.0010
	1.07	.045	.0366	-.0126	-.0013	-.02	-.03	-.0088	-.0080
	2.15	.093	.0388	-.0238	-.0016	-.05	-.09	-.0238	-.0254
49	.54	.038	.0108	-.0115	-.0046	2.96	2.98	-.0245	-.0112
	-.52	-.001	.0106	-.0104	-.0046	2.96	2.98	-.0260	-.0121
	-1.07	-.028	.0109	-.0096	-.0047	2.96	2.97	-.0260	-.0138
	-3.25	-.134	.0144	-.0038	-.0050	2.96	2.96	-.0245	-.0173
	-6.48	-.302	.0310	.0097	-.0056	2.97	2.96	-.0184	-.0208
	1.09	.065	.0113	-.0124	-.0046	2.96	2.98	-.0245	-.0094
	2.18	.117	.0130	-.0152	-.0046	2.96	3.67	-.0260	.3341
	4.34	.223	.0196	-.0218	-.0045	2.96	2.98	-.0275	-.0094
	6.50	.338	.0349	-.0312	-.0040	2.95	2.97	-.0322	-.0155
	8.66	.461	.0602	-.0432	-.0032	2.94	2.93	-.0382	-.0362
	10.84	.590	.0987	-.0565	-.0032	2.94	2.82	-.0412	-.0870
	12.99	.690	.1436	-.0634	-.0026	2.92	2.75	-.0565	-.1249
	15.11	.761	.1914	-.0652	-.0048	2.89	2.71	-.0794	-.1411
50	.44	.038	.0110	-.0122	-.0047	2.95	2.97	-.0269	-.0103
	-.54	-.006	.0109	-.0108	-.0047	2.95	2.96	-.0281	-.0137
	-1.10	-.034	.0111	-.0100	-.0047	2.94	2.96	-.0305	-.0158
50	-3.32	-0.148	0.0155	-0.0028	-0.0050	2.95	2.95	-0.0293	-0.0206
	-6.63	-.345	.0264	.0156	-.0056	2.95	2.94	-.0244	-.0220
	1.11	.066	.0115	-.0133	-.0046	2.95	2.98	-.0255	-.0088
	2.23	.125	.0135	-.0167	-.0048	2.95	2.98	-.0267	-.0061
	4.42	.241	.0217	-.0244	-.0047	2.95	2.97	-.0278	-.0115
	6.64	.374	.0427	-.0366	-.0038	2.94	2.94	-.0302	-.0218
	8.85	.506	.0760	-.0516	-.0043	2.93	2.86	-.0398	-.0544
	11.04	.620	.1192	-.0647	-.0047	2.91	2.73	-.0494	-.1039
	13.18	.696	.1646	-.0680	-.0016	2.83	2.67	-.0961	-.1286
	15.30	.759	.2113	-.0753	-.0035	2.77	2.66	-.1320	-.1332
51	.44	.035	.0112	-.0126	-.0047	2.94	2.97	-.0303	-.0094
	-.55	-.009	.0110	-.0119	-.0049	2.93	2.96	-.0360	-.0126
	-1.12	-.041	.0114	-.0104	-.0050	2.92	2.96	-.0393	-.0158
	-3.37	-.169	.0173	.0006	-.0050	2.92	2.95	-.0393	-.0170
	-6.74	-.400	.0494	.0344	-.0048	2.92	2.98	-.0413	-.0088
	1.12	.067	.0119	-.0136	-.0046	2.95	2.98	-.0268	-.0069
	2.25	.132	.0144	-.0175	-.0048	2.95	2.99	-.0256	-.0037
	4.49	.267	.0252	-.0294	-.0048	2.96	2.97	-.0211	-.0100
	6.74	.428	.0524	-.0557	-.0046	2.97	2.94	-.0132	-.0218
	8.92	.526	.0875	-.0628	-.0029	2.90	2.70	-.0530	-.1066
52	.54	.028	.0357	-.0059	-.0026	2.87	2.76	-.0562	-.0742
	-.53	-.015	.0359	.0014	-.0025	2.89	2.78	-.0477	-.0682
	-1.09	-.049	.0368	.0075	-.0023	2.91	2.79	-.0400	-.0659
	-3.27	-.175	.0447	.0319	-.0022	2.97	2.84	-.0132	-.0486
	-6.51	-.375	.0740	.0764	-.0025	3.05	2.89	.0226	-.0346
53	.55	.028	.0362	-.0061	-.0028	2.88	2.76	-.0495	-.0703
	-.52	.010	.0364	.0015	-.0027	2.91	2.79	-.0387	-.0634
	-1.07	.039	.0371	.0073	-.0028	2.92	2.80	-.0313	-.0592
	-3.24	.152	.0444	.0304	-.0028	2.99	2.86	-.0009	-.0445
	-6.46	.329	.0712	.0716	-.0027	3.09	2.99	.0409	-.0021
54	.42	.025	.0362	-.0100	-.0025	2.90	2.81	-.0431	-.0562
	-.53	-.010	.0368	-.0017	-.0024	2.92	2.84	-.0323	-.0470
	-1.07	-.031	.0372	.0030	-.0023	2.93	2.85	-.0259	-.0429
	-3.21	-.124	.0427	.0246	-.0018	3.00	2.92	-----	-.0216
	-6.38	-.267	.0657	.0583	-.0013	3.09	3.12	.0424	.0346

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TABLE IV.- CONTINUED

(g) Tests 55 through 60

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
55	0.47	-0.060	0.0157	0.0241	0.0094	0.08	-14.54	0.0464	0.1639
	1.09	.018	.0154	.0198	.0087	.08	-14.54	.0481	.1658
	2.23	.084	.0172	.0147	.0084	.08	-14.52	.0458	.1727
	4.47	.214	.0259	.0023	.0081	.07	-14.50	.0424	.1796
	6.71	.373	.0491	-.0249	.0079	.08	-14.55	.0446	.1634
56	-.41	-.038	.0398	.0218	.0077	.07	-13.99	.0344	.3133
	.56	.009	.0396	.0134	.0074	.05	-13.98	.0238	.3132
	1.12	.040	.0397	.0076	.0071	.03	-14.00	.0170	.3068
	2.22	.098	.0416	-.0032	.0069	.01	-14.04	.0057	.2960
	4.38	.225	.0524	-.0291	.0068	-.04	-14.09	-.0218	.2794
	6.54	.363	.0743	-.0608	.0071	-.10	-14.23	-.0492	.2357
57	.54	.005	.0123	.0117	.0043	.06	-7.81	.0317	.0667
	1.11	.037	.0128	.0095	.0042	.06	-7.80	.0328	.0692
	2.24	.098	.0149	.0052	.0042	.06	-7.79	.0317	.0728
	4.48	.230	.0244	-.0076	.0043	.06	-7.80	.0317	.0703
	6.72	.380	.0478	-.0298	.0055	.06	-7.86	.0339	.0505
	8.92	.491	.0836	-.0420	.0051	.01	-7.91	.0087	.0314
	11.06	.554	.1223	-.0410	.0038	-.05	-7.87	-.0261	.0455

Test No.	α	C_L	C_D	C_m	C_l	δ_{c_i}	δ_{c_o}	C_{h_i}	C_{h_o}
58	0.41	-0.028	0.0372	0.0138	0.0037	0.05	-7.45	0.0230	0.1694
	.56	.020	.0370	.0056	.0035	.02	-7.46	.0134	.1658
	1.11	.046	.0374	.0009	.0035	.01	-7.48	.0066	.1617
	2.21	.106	.0394	-.0102	.0033	0	-7.51	-.0019	.1510
	4.37	.235	.0507	-.0365	.0032	-.06	-7.56	-.0313	.1336
	6.54	.373	.0735	-.0680	.0036	-.13	7.65	-.0614	.1070
59	.55	.020	.0111	.0019	.0009	.02	-2.96	.0108	.0122
	1.11	.047	.0116	.0007	.0008	.02	-2.96	.0119	.0140
	2.24	.106	.0136	-.0030	.0008	.02	-2.95	.0141	.0165
	4.48	.241	.0235	-.0144	.0011	.02	-2.95	.0141	.0171
	6.73	.387	.0476	-.0330	.0022	.02	-3.01	.0119	-.0042
	8.92	.500	.0838	-.0479	.0039	0	-3.16	-.0043	-.0557
60	-.41	-.021	.0361	.0087	.0013	.02	-2.78	.0123	.0690
	.56	.022	.0359	.0012	.0011	0	-2.79	.0028	.0652
	1.11	.051	.0363	-.0038	.0010	0	-2.80	0	.0608
	2.20	.112	.0384	-.0148	.0010	-.02	-2.83	-.0123	.0527
	4.37	.241	.0498	-.0411	.0008	-.08	-2.88	-.0396	.0356

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TABLE IV.- CONTINUED

(h) Tests 61 through 68

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
61	-0.51	0.39	0.0005	-0.002	-0.0002	-0.037	0.0113	-0.0009	0	-0.0020
	-.51	.88	.0011	-.006	-.0002	-.038	.0113	-.0010	0	-.0026
	-.51	2.87	.0033	-.019	-.0005	-.039	.0120	-.0009	0	-.0030
	-.51	4.96	.0053	-.033	-.0005	-.041	.0137	-.0007	0	.0036
	-.51	-.50	0	.002	-.0002	-.037	.0113	-.0010	0	.0015
	-.51	-.99	-.0004	.006	-.0001	-.037	.0112	-.0012	0	.0030
	-.51	-2.98	-.0024	.019	----	-.037	.0118	-.0015	0	.0056
	-.50	-4.96	-.0041	.032	----	-.037	.0133	-.0019	0	.0010
62	0	-.50	-.0003	.003	.0004	.004	.0352	.0052	-.02	-.0062
	0	-.99	-.0009	.006	.0008	.005	.0355	.0048	-.03	-.0111
	0	-2.97	-.0031	.018	.0024	.005	.0365	.0040	-.10	-.0381
	0	-4.95	-.0053	.032	.0041	.001	.0385	.0031	-.15	-.0606
	0	.39	.0005	-.003	-.0003	.004	.0358	.0049	.01	.0029
	0	.88	.0012	-.006	-.0008	.005	.0359	.0049	.02	.0079
	0	2.86	.0036	-.019	-.0025	.004	.0367	.0041	.08	.0305
	0	4.84	.0058	-.032	-.0041	.002	.0387	.0032	.14	.0543
63	-.51	1.00	.0004	-.004	----	-.038	.0116	-.0001	1.99	-.0052
	-.51	2.98	.0025	-.018	-.0001	-.039	.0120	----	1.99	-.0067
	-.51	4.96	.0040	-.029	-.0002	-.041	.0135	-.0004	1.99	-.0036
	-.51	-.50	-.0007	.004	.0001	-.038	.0114	-.0010	2.00	-.0004
	-.51	-.99	-.0012	.007	.0001	-.037	.0114	-.0006	2.00	.0010
	-.51	-2.98	-.0032	.020	.0003	-.036	.0121	-.0018	2.00	.0010
	-.51	-4.96	-.0050	.033	.0006	-.038	.0136	-.0017	1.99	-.0066
64	0	-.39	-.0008	.004	.0005	.002	.0363	.0052	1.94	-.0229
	0	-.88	-.0015	.007	.0009	.002	.0365	.0051	1.93	-.0287
	0	-2.86	-.0038	.020	.0024	.002	.0377	.0042	1.86	-.0557
	0	-4.95	-.0061	.034	.0041	----	.0396	.0032	1.81	-.0783
	0	.50	.0001	-.002	-.0003	.001	.0362	.0051	1.97	-.0129
	0	.99	.0005	-.004	-.0007	.002	.0364	.0048	1.98	-.0087
	0	2.97	.0031	-.017	-.0023	.001	.0373	.0043	2.04	.0145
	0	4.95	.0053	-.030	-.0041	.001	.0391	.0028	2.10	.0394

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
65	-0.51	0.60	-0.0013	0.001	0.0002	-0.039	0.0119	0	3.98	-0.0076
	-.51	.99	-.0008	-.002	----	-.039	.0118	-.0004	3.98	-.0086
	-.51	2.98	.0012	-.015	-.0001	-.040	.0120	-.0009	3.98	-.0097
	-.51	4.96	.0027	-.027	-.0001	-.042	.0131	-.0006	3.98	-.0112
	-.51	-.39	-.0019	.007	.0002	-.039	.0114	-.0003	3.99	-.0040
	-.51	-.88	-.0084	.010	.0008	-.038	.0115	-.0004	----	-.0040
	-.51	-2.87	-.0046	.023	.0005	-.038	.0122	-.0010	3.99	-.0061
	-.51	-4.85	-.0067	.037	.0008	-.039	.0139	-.0014	3.97	-.0157
66	0	-.39	-.0019	.006	.0008	.004	.0362	.0052	3.87	-.0540
	0	-.88	-.0025	.010	.0012	.005	.0364	.0048	3.85	-.0603
	0	-2.86	-.0047	.022	.0029	.004	.0374	.0045	3.79	-.0873
	0	-4.84	-.0071	.036	.0046	.002	.0397	.0031	3.73	-.1093
	0	.50	-.0007	0	-.0001	.003	.0363	.0054	3.89	-.0436
	0	.99	-.0001	-.004	-.0005	.004	.0364	.0049	3.90	-.0388
	0	2.97	.0022	-.016	-.0022	.003	.0372	.0040	3.96	-.0170
	0	4.95	.0043	-.029	-.0038	.001	.0392	.0029	4.12	----
67	-.51	.60	-.0023	.006	.0005	-.038	.0119	-.0004	5.97	-.0148
	-.51	.99	-.0019	0	.0005	-.038	.0116	-.0005	5.97	-.0153
	-.51	2.98	.0002	-.013	.0002	-.037	.0120	-.0011	5.97	-.0147
	-.51	4.96	.0013	-.024	.0003	-.038	.0133	-.0008	5.97	-.0163
	-.51	-.39	-.0030	.009	.0006	-.039	.0117	-.0002	5.97	-.0116
	-.51	-.88	-.0036	.012	.0007	-.039	.0117	-.0008	5.97	-.0116
	-.51	-2.87	-.0059	.027	.0009	-.039	.0125	-.0015	5.97	-.0148
	-.51	-4.85	-.0080	.039	.0011	-.041	.0143	-.0017	5.95	-.0254
68	0	-.39	-.0022	.006	.0010	.004	.0364	.0052	5.80	-.0814
	0	-.88	-.0026	.009	.0014	.005	.0365	.0050	5.78	-.0871
	0	-2.86	-.0051	.022	.0031	.005	.0375	.0044	5.72	-.1123
	0	-4.84	-.0074	.035	.0048	.003	.0396	.0031	5.67	-.1338
	0	.49	-.0010	0	0	.004	.0363	.0050	5.83	-.0689
	0	.99	-.0006	0	-.0003	.005	.0364	.0049	5.84	-.0630
	0	2.97	.0014	-.015	-.0020	.005	.0373	.0040	5.89	-.0422
	0	4.95	.0036	-.028	-.0036	.003	.0390	.0027	5.96	-.0144

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TABLE IV.- CONTINUED

(i) Tests 69 through 76

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
69	-0.01	-0.39	-0.0047	0.013	0.0010	-0.038	0.0116	-0.0005	7.96	-0.0208
	-.01	-.88	-.0054	.017	.0010	-.039	.0118	-.0005	7.96	-.0207
	-.01	-2.87	-.0077	.030	.0013	-.039	.0127	-.0014	7.95	-.0263
	-.01	-4.85	-.0100	.044	.0014	-.041	.0146	-.0021	7.92	-.0373
	-.01	.60	-.0040	.007	.0009	-.038	.0116	-.0007	7.95	-.0234
	-.01	1.10	-.0033	.003	.0009	-.036	.0114	-.0011	7.95	-.0234
	-.01	2.97	-.0010	-.011	.0006	-.038	.0118	-.0008	7.96	-.0203
	-.01	4.97	.0030	-.022	.0005	-.038	.0129	-.0013	7.96	-.0193
70	------	-.39	-.0033	.008	.0014	.005	.0367	.0050	7.72	-.1096
	------	-.88	-.0038	.011	.0018	.005	.0368	.0047	7.71	-.1161
	------	-2.86	-.0061	.024	.0034	.005	.0381	.0041	7.64	-.1410
	------	-4.84	-.0084	.038	.0051	.003	.0405	.0031	7.60	-.1577
	------	.49	-.0020	.001	.0004	.005	.0366	.0049	7.75	-.0983
	------	.99	-.0015	-.001	------	.005	.0365	.0047	7.76	-.0934
	------	2.97	.0006	-.013	-.0018	.005	.0373	.0041	7.81	-.0732
	------	4.95	.0028	-.026	-.0033	.003	.0390	.0028	7.88	-.0448
71	-.01	-.50	.0010	0	-.0003	-.030	.0106	-.0007	----	-----
	-.01	-.99	.0014	.001	-.0004	-.031	.0105	-.0007	----	-----
	-.01	-2.98	.0033	.003	-.0008	-.030	.0105	-.0007	----	-----
	-.01	-4.96	.0053	.006	-.0012	-.030	.0106	-.0010	----	-----
	-.01	.50	-.0003	-.001	-.0002	-.032	.0105	-.0003	----	-----
	-.01	1.00	-.0007	-.002	-----	-.031	.0104	-.0004	----	-----
	-.01	2.98	-.0028	-.003	.0004	-.032	.0107	-.0001	----	-----
	-.01	4.96	-.0049	-.006	.0010	-.033	.0110	-.0004	----	-----
72	-----	-.49	.0007	.001	0	.009	.0336	.0026	----	-----
	-----	-.99	.0011	.002	.0001	.008	.0337	.0028	----	-----
	-----	-2.96	.0029	.007	.0004	.007	.0342	.0023	----	-----
	-----	-4.94	.0047	.011	.0008	.006	.0351	.0007	----	-----
	-----	.50	-.0001	-.001	-.0002	.008	.0337	.0029	----	-----
	-----	.99	-.0009	-.001	-.0002	.008	.0338	.0029	----	-----
	-----	2.97	-.0026	-.005	-.0006	.006	.0342	.0027	----	-----
	-----	4.95	-.0045	-.009	-.0009	.004	.0351	.0014	----	-----

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
73	5.11	-0.50	0.0001	0.002	0.0007	0.287	0.0282	-0.0248	0	-0.0010
	5.11	-.99	-.0002	.004	.0016	.289	.0286	-.0252	0	-.0004
	5.11	-2.98	-.0024	.016	.0051	.288	.0291	-.0259	0	.0015
	5.11	-4.96	-.0048	.029	.0086	.287	.0305	-.0255	0	-.0004
	5.11	.39	.0005	-.003	-.0006	.288	.0283	-.0258	0	-.0010
	5.11	.99	.0011	-.006	-.0015	.289	.0284	-.0264	0	-.0004
	5.11	2.98	.0037	-.019	-.0052	.288	.0292	-.0256	0	-.0015
	5.11	4.96	.0061	-.032	-.0088	.292	.0312	-.0267	0	.0020
74	4.82	-.50	0	.002	.0005	.276	.0562	-.0570	0	.0008
	4.82	-.99	-.0003	.005	.0010	.277	.0564	-.0572	-.01	-.0029
	4.82	-2.97	-.0028	.016	.0037	.277	.0576	-.0572	-.06	-.0237
	4.82	-4.95	-.0048	.028	.0063	.273	.0590	-.0569	-.10	-.0410
	4.82	.39	.0009	-.004	-.0009	.280	.0564	-.0579	.02	.0100
	4.82	.88	.0015	-.007	-.0016	.280	.0565	-.0578	.04	.0146
	4.82	2.86	.0040	-.019	-.0045	.276	.0569	-.0571	.08	.0332
	4.82	4.95	.0060	-.031	-.0071	.274	.0587	-.0574	.12	.0505
75	5.11	-.39	-.0019	.005	.0012	.284	.0282	-.0245	3.98	-.0072
	5.11	-.88	-.0024	.008	.0019	.284	.0282	-.0692	3.98	-.0078
	5.11	-2.87	-.0047	.022	.0054	.285	.0292	-----	3.98	-.0077
	5.11	-4.85	-.0071	.035	.0090	.284	.0308	-.0253	3.97	-.0129
	5.11	.50	-.0007	-.001	-.0003	.283	.0281	-.0240	3.99	-.0066
	5.11	.99	-.0004	-.003	-.0013	.287	.0284	-.0254	3.99	-.0061
	5.11	2.98	.0016	-.016	-.0049	.287	.0287	-.0258	3.99	-.0066
	5.11	4.96	.0039	-.029	-.0085	.286	.0302	-.0255	3.98	-.0077
76	4.86	-.39	-.0011	.004	.0006	.291	.0576	-.0600	3.88	-.0476
	4.86	-.88	-.0017	.007	.0013	.290	.0576	-.0598	3.87	-.0521
	4.86	-2.86	-.0042	.019	.0041	.288	.0586	-.0593	3.82	-.0731
	4.86	-4.95	-.0064	.032	.0067	.285	.0604	-.0594	3.78	-.0912
	4.86	.50	-.0002	-.001	-.0006	.291	.0575	-.0600	3.90	-.0385
	4.86	.99	.0001	-.003	-.0013	.291	.0577	-.0602	3.91	-.0347
	4.86	2.97	.0024	-.016	-.0042	.291	.0584	-.0605	3.96	-.0158
	4.86	4.95	.0046	-.028	-.0068	.290	.0601	-.0607	4.02	.0075

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TABLE IV.- CONTINUED

(j) Tests 77 through 84

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
77	4.95	-0.39	-0.0037	0.009	0.0014	0.283	0.0277	-0.0256	7.96	-0.0204
	4.94	-.89	-.0044	.012	.0023	.281	.0277	-.0245	7.96	-.0214
	4.95	-2.87	-.0068	.026	.0057	.283	.0289	-.0255	7.95	-.0240
	4.95	-4.85	-.0095	.041	.0093	.283	.0308	-.0260	7.94	-.0301
	4.47	.60	-.0029	.004	0	- - -	.0333	-.0250	7.96	-.0198
	4.95	1.10	-.0026	.001	-.0009	.285	.0274	-.0255	7.96	-.0188
	4.95	2.97	-.0003	-.012	-.0046	.286	.0277	-.0260	7.96	-.0172
	4.95	4.96	.0019	-.025	-.0082	.286	.0289	-.0262	7.97	-.0162
78	4.82	-.39	-.0022	.006	.0010	.289	.0574	-.0592	7.77	-.0946
	4.82	-.88	-.0028	.009	.0017	.290	.0574	-.0595	7.76	-.1004
	4.82	-2.86	-.0056	.021	.0043	.288	.0588	-.0590	7.70	-.1227
	4.82	-4.84	-.0077	.033	.0067	.285	.0606	-.0590	7.67	-.1350
	4.82	.49	-.0014	0	-.0003	.289	.0570	-.0593	7.79	-.0833
	4.82	.99	-.0008	-.002	-.0010	.290	.0573	-.0597	7.80	-.0790
	4.82	2.97	.0012	-.014	-.0038	.290	.0581	-.0598	7.85	-.0610
	4.82	4.94	.0032	-.026	-.0062	.288	.0598	-.0604	7.91	-.0360
79	5.11	-.50	.0007	.001	.0009	.296	.0288	-.0272	- - -	- - -
	5.11	-.99	.0011	.001	.0017	.291	.0283	-.0254	- - -	- - -
	5.11	-2.98	.0023	.004	.0048	.293	.0288	-.0256	- - -	- - -
	5.11	-4.96	.0040	.006	.0080	.293	.0294	-.0257	- - -	- - -
	5.11	.50	-.0003	0	-.0007	.296	.0283	-.0267	- - -	- - -
	5.11	1.00	-.0007	-.001	-.0016	.294	.0284	-.0262	- - -	- - -
	5.11	2.98	-.0023	-.004	-.0048	.295	.0286	-.0262	- - -	- - -
	5.11	4.96	-.0041	-.007	-.0081	.293	.0293	-.0254	- - -	- - -
80	5.00	-.50	.0005	.001	.0002	.289	.0558	-.0609	- - -	- - -
	5.00	-.99	.0010	.002	.0007	.289	.0558	-.0608	- - -	- - -
	5.00	-2.97	.0021	.006	.0025	.286	.0561	-.0602	- - -	- - -
	5.00	-4.94	.0036	.011	.0041	.283	.0567	-.0602	- - -	- - -
	5.00	.50	0	-.002	-.0007	.290	.0560	-.0611	- - -	- - -
	5.00	.99	-.0002	-.002	-.0013	.288	.0559	-.0608	- - -	- - -
	5.00	2.97	-.0015	-.008	-.0031	.287	.0563	-.0606	- - -	- - -
	5.00	4.94	-.0031	-.012	-.0047	.285	.0572	-.0607	- - -	- - -

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
81	10.73	-0.61	0.0001	-0.002	0.0016	0.600	0.1078	-0.0596	- - -	0
	10.73	-1.00	-.0002	-.001	.0018	.600	.1080	-.0549	- - -	.0005
	10.72	-2.98	-.0021	.011	.0022	.595	.1082	-.0549	- - -	.0011
	10.72	-4.96	-.0047	.022	.0037	.590	.1085	-.0558	- - -	-.0005
	10.72	.38	.0015	-.008	.0007	.595	.1070	-.0542	- - -	-.0005
	10.72	.88	.0021	-.011	.0004	.595	.1012	-.0543	- - -	-.0005
	10.72	2.97	.0041	-.021	-.0009	.591	.1076	-.0544	- - -	.0016
	10.72	4.95	.0068	-.034	-.0027	.589	.1088	-.0561	- - -	.0056
82	10.50	-.61	.0001	-.002	-.0004	.562	.1325	-.1258	- - -	.0038
	10.50	-.99	.0001	0	- - -	.561	.1323	-.1252	- - -	.0037
	10.50	-2.97	-.0012	.008	.0023	.560	.1325	-.1256	-0.01	-.0524
	10.50	-4.94	-.0029	.017	.0052	.557	.1334	-.1257	-.03	-.1173
	10.50	.49	.0008	-.005	-.0010	.554	.1310	-.1244	- - -	.0037
	10.50	.98	.0012	-.007	-.0017	.554	.1310	-.1242	- - -	.0116
	10.50	2.96	.0028	-.015	-.0045	.552	.1315	-.1248	- - -	.0759
	10.50	4.93	.0043	-.024	-.0066	.552	.1332	-.1249	- - -	.1370
83	10.73	-.39	-.0010	.001	.0013	.601	.1090	-.0571	3.99	-.0039
	10.73	-.89	-.0018	.004	.0015	.604	.1095	-.0572	3.99	-.0039
	10.72	-2.87	-.0041	.015	.0016	.598	.1103	-.0576	3.98	-.0078
	10.72	-4.85	-.0070	.028	.0033	.593	.1107	-.0577	3.98	-.0117
	10.73	.49	-.0001	-.004	.0009	.601	.1086	-.0568	3.99	-.0033
	10.72	.99	.0004	-.007	.0005	.595	.1078	-.0560	3.99	-.0044
	10.72	2.97	.0025	-.017	-.0014	.593	.1083	-.0572	3.99	-.0049
	10.72	4.95	.0048	-.029	-.0030	.592	.1095	-.0587	3.99	-.0032
84	10.50	-.39	-.0006	.001	-.0003	.589	.1370	-.1314	3.94	-.0234
	10.50	-.88	-.0008	.003	.0004	.590	.1371	-.1318	3.94	-.0251
	10.50	-2.97	-.0028	.011	.0024	.589	.1377	-.1318	3.91	-.0346
	10.50	-4.95	-.0043	.019	.0052	.585	.1386	-.1317	3.89	-.0433
	10.50	.49	.0001	-.002	-.0010	.589	.1369	-.1320	3.95	-.0205
	10.50	.98	.0003	-.005	-.0018	.590	.1372	-.1325	3.96	-.0176
	10.50	2.96	.0018	-.013	-.0046	.588	.1376	-.1325	3.97	-.0112
	10.50	4.93	.0031	-.021	-.0067	.583	.1382	-.1320	3.99	-.0025

NACA

TABLE IV.- CONCLUDED

(k) Tests 85 through 88

Test No.	α	β	C_n	C_c	C_l	C_L	C_D	C_m	δ_r	C_{h_r}
85	10.73	-0.39	-0.0029	0.006	0.0008	0.610	0.1103	-0.0565	7.87	-0.0189
	10.73	-.89	-.0041	.009	.0012	.611	.1103	-.0573	7.86	-.0195
	10.73	-2.87	-.0064	.021	.0013	.606	.1113	-.0576	7.85	-.0286
	10.73	-4.86	-.0096	.034	.0031	.603	.1126	-.0578	7.84	-.0348
	10.83	.49	-.0023	----	.0006	.872	----	-.0572	7.87	-.0177
	10.73	.99	-.0019	-.001	.0002	.610	.1101	-.0570	7.87	-.0171
	10.73	2.97	-.0001	-.010	-.0016	.602	.1093	-.0567	7.87	-.0182
	10.73	4.96	.0023	-.022	-.0032	.603	.1105	-.0590	7.87	-.0159
86	10.50	-.39	-.0016	.003	-.0003	.584	.1368	-.1303	7.74	-.0668
	10.50	-.89	-.0020	.005	.0003	.579	.1358	-.1292	7.73	-.0683
	10.50	-2.86	-.0035	.013	.0027	.586	.1379	-.1312	7.71	-.0798
	10.50	-4.95	-.0052	.021	.0050	.586	.1395	-.1320	7.70	-.0835
	10.50	.49	-.0010	-.001	-.0011	.592	.1380	-.1323	7.75	-.0610
	10.50	.98	-.0005	-.003	-.0017	.592	.1381	-.1326	7.76	-.0576
	10.50	2.96	.0008	-.011	-.0044	.592	.1389	-.1333	7.79	-.0461
	10.50	4.94	.0020	-.019	-.0065	.589	.1396	-.1330	7.82	-.0311
87	10.73	-.61	.0002	-.003	.0017	.602	.1084	-.0532	----	----
	10.73	-1.11	.0004	-.002	.0019	.601	.1079	-.0528	----	----
	10.72	-.298	.0016	0	.0021	.597	.1086	-.0529	----	----
	10.72	-4.97	.0030	.002	.0033	.595	.1088	-.0522	----	----
	10.73	.49	-.0002	-.004	.0011	.600	.1082	-.0524	----	----
	10.72	.99	-.0002	-.005	.0009	.598	.1081	-.0522	----	----
	10.72	2.97	-.0018	-.006	-.0008	.591	.1075	-.0509	----	----
	10.72	4.96	-.0033	-.009	-.0023	.588	.1077	-.0512	----	----
88	10.50	-.50	0	-.002	.0001	.573	.1323	-.1108	----	----
	10.50	-1.00	.0005	-.001	.0005	.576	.1327	-.1114	----	----
	10.50	-2.97	.0016	.002	.0020	.576	.1330	-.1121	----	----
	10.50	-4.94	.0029	.006	.0042	.573	.1334	-.1118	----	----
	10.50	.49	-.0002	-.004	-.0008	.583	.1341	-.1133	----	----
	10.50	.98	-.0003	----	-.0015	.583	----	-.1137	----	----
	10.50	2.96	-.0012	-.007	-.0035	.581	.1344	-.1139	----	----
	10.50	4.92	-.0027	-.011	-.0052	.577	.1347	-.1130	----	----

NACA

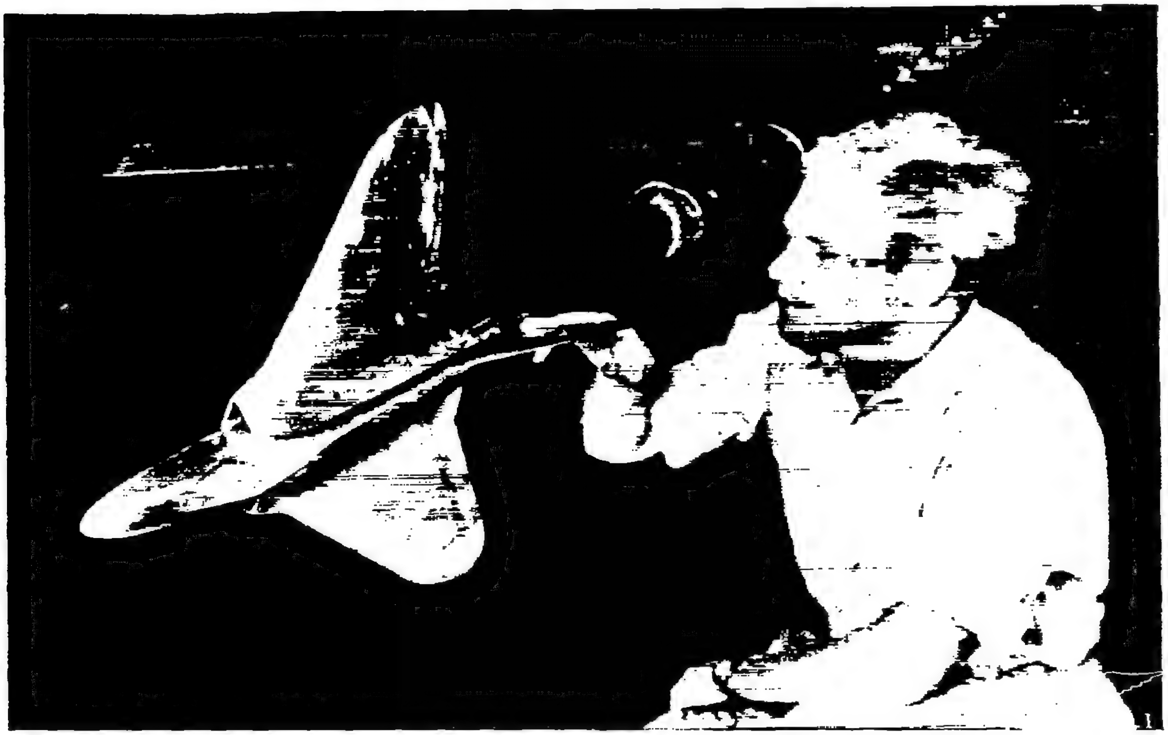


Figure 1.– The model mounted in the Ames 6– by 6–foot wind tunnel.

Geometric characteristics	Basic wing	Modified wing
wing area, square feet	1.68	1.91
aspect ratio	2.03	3.98
taper ratio	.332	0
$\bar{c}$	12.04	11.03
$\bar{X}$	5.88	7.19
$\bar{Y}$	4.51	5.52

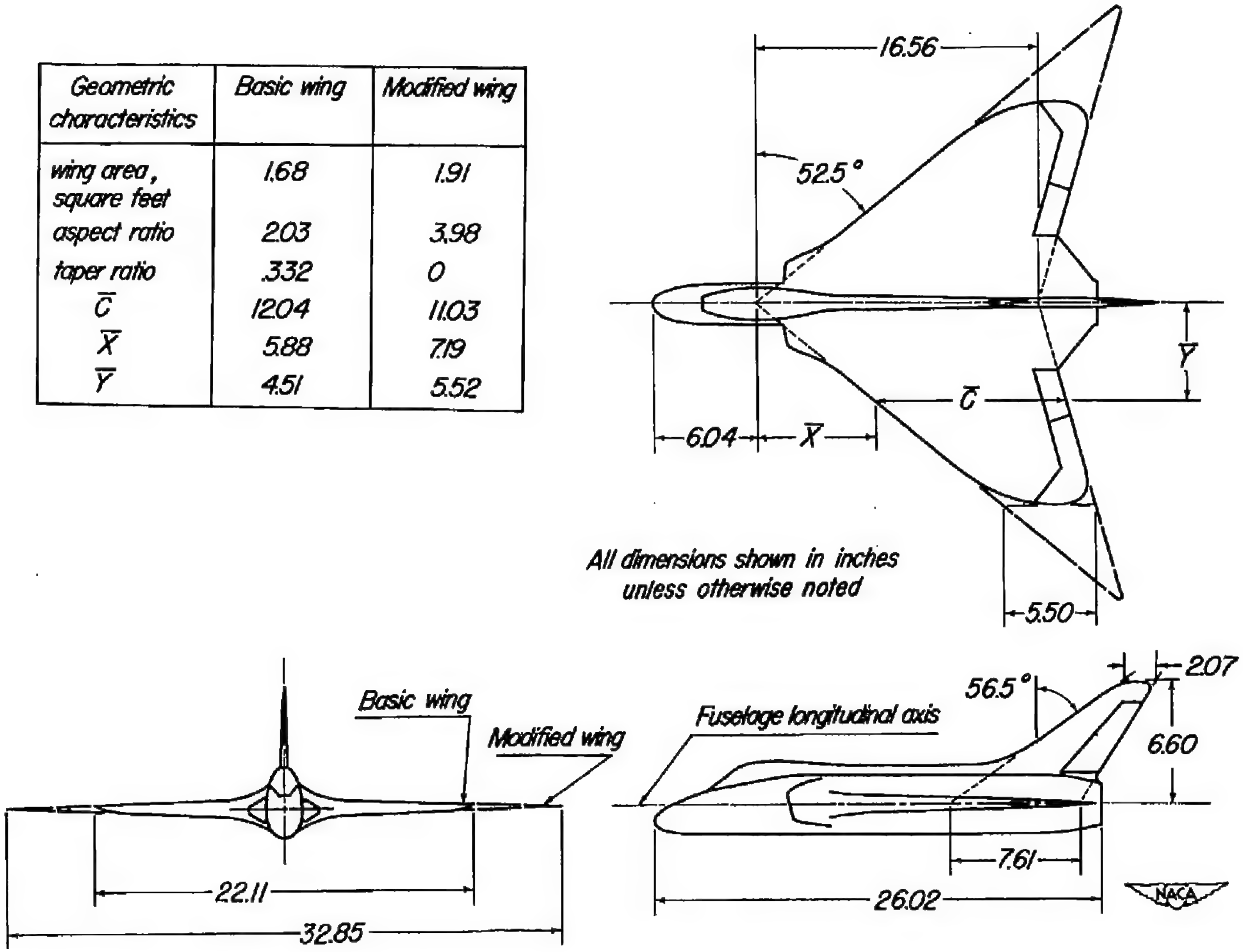
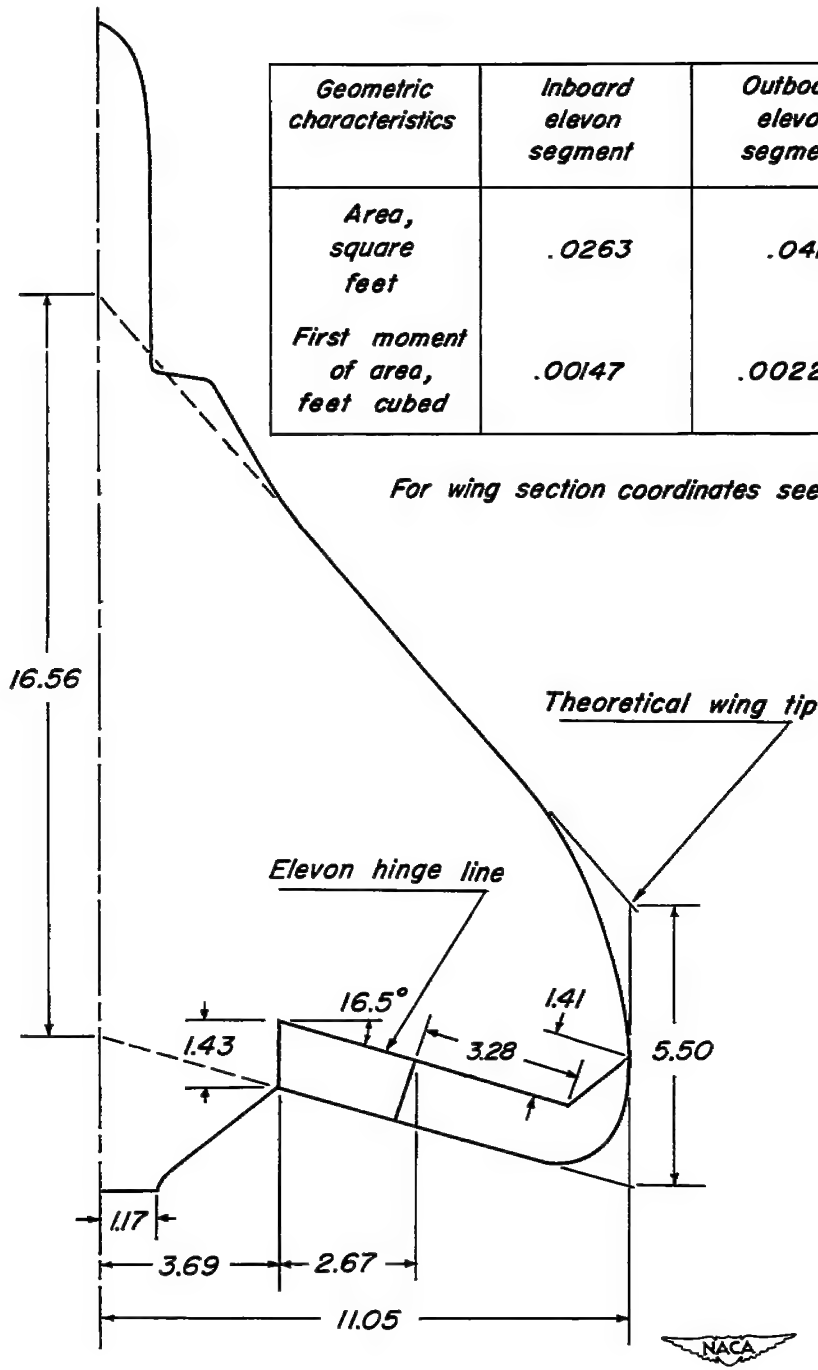


Figure 2.- Three-view drawing of the model.



Geometric characteristics	Inboard elevon segment	Outboard elevon segment
Area, square feet	.0263	.0418
First moment of area, feet cubed	.00147	.00222

For wing section coordinates see Table I

Figure 3.— Details of control surfaces on the right wing panel of the model.

[redacted]

Geometric characteristics	
rudder area, square feet	.0375
first moment of area, feet cubed	.00163

For vertical tail section coordinates see Table II

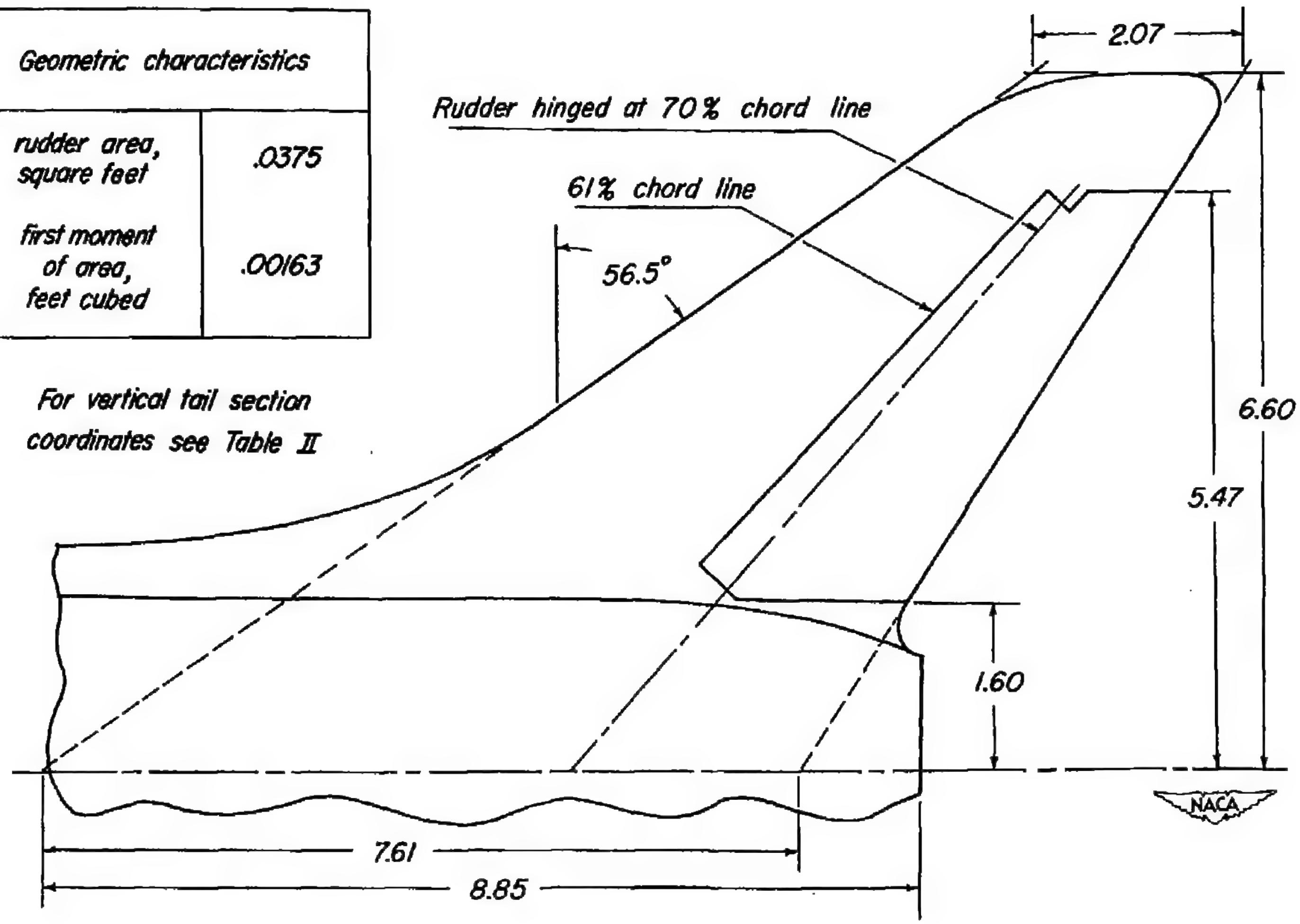
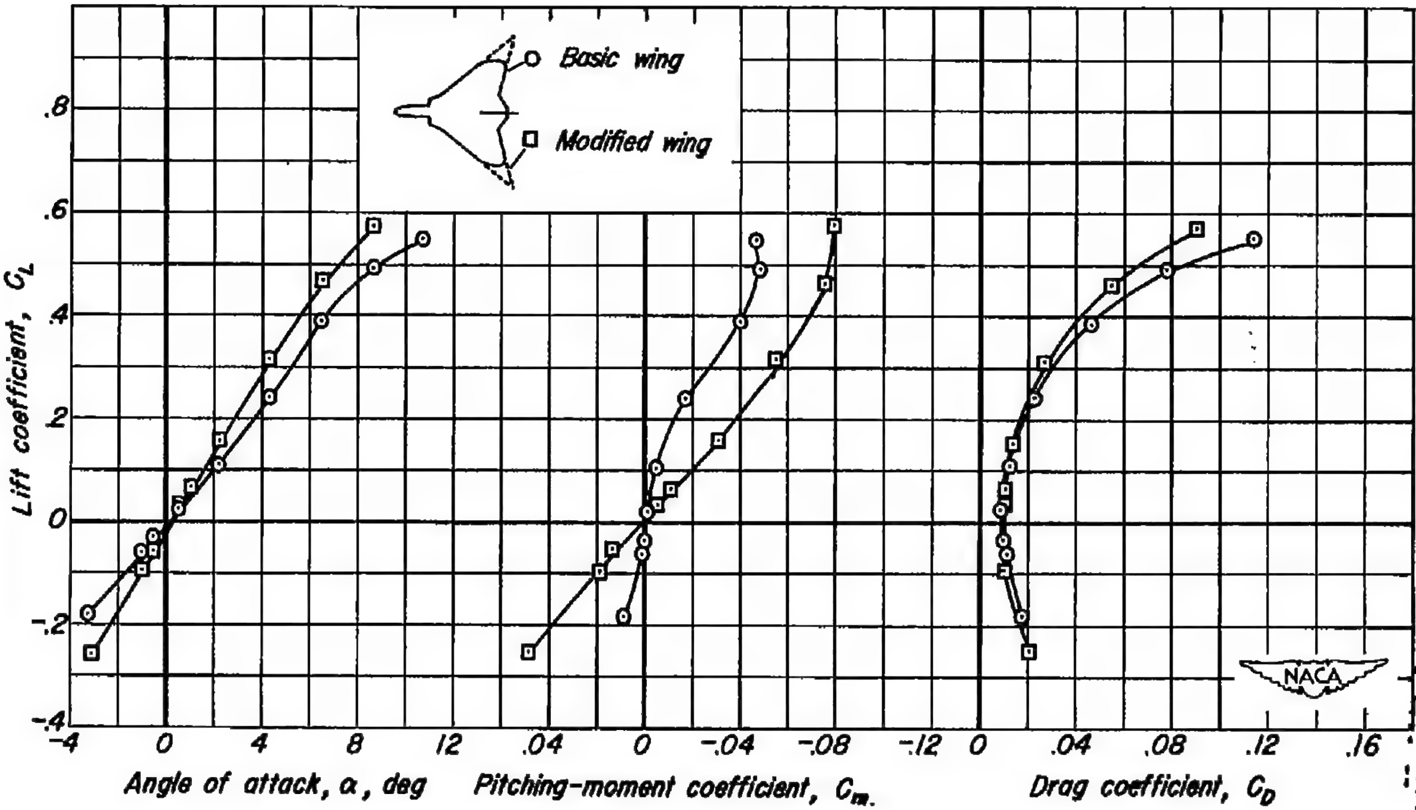
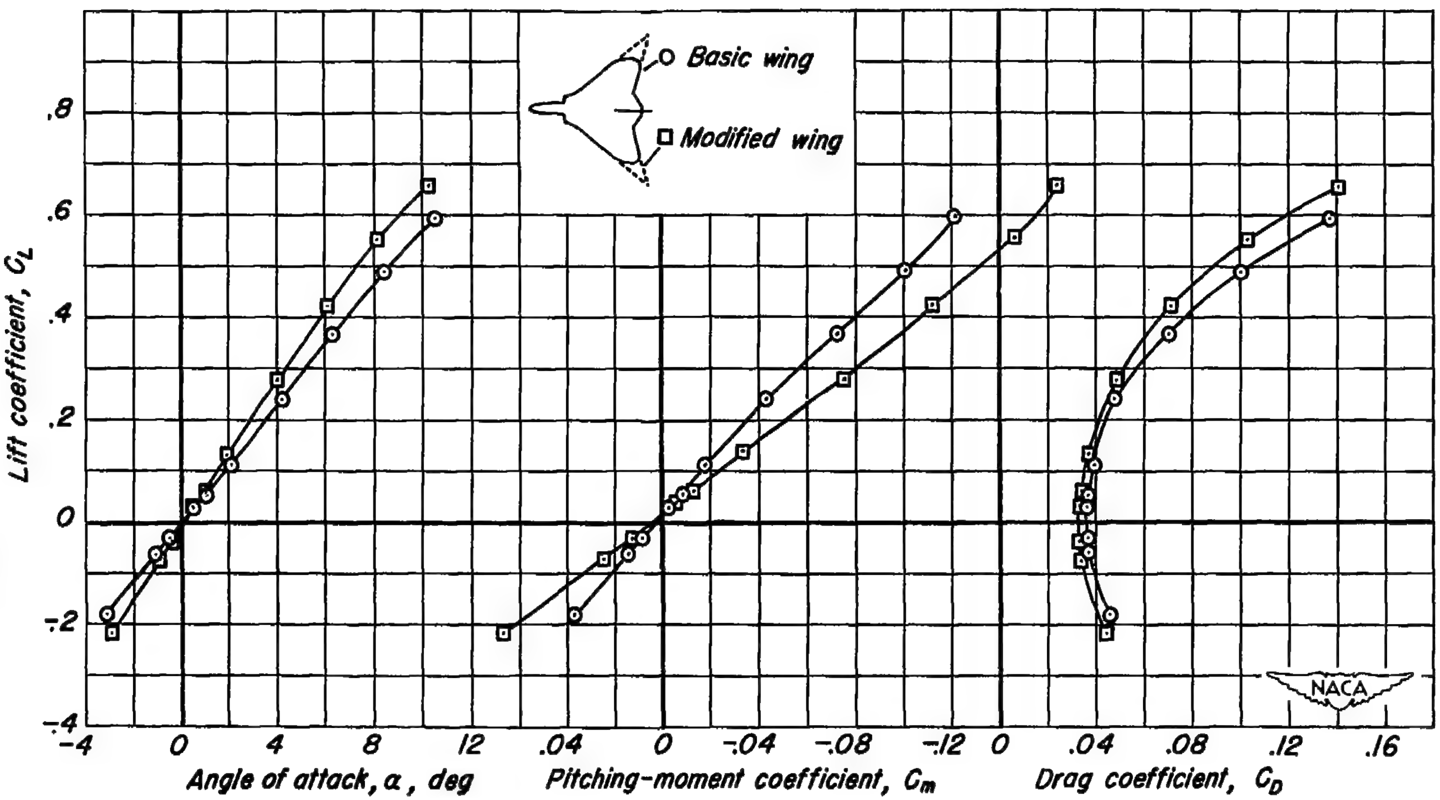


Figure 4.— Details of the vertical tail of the model.



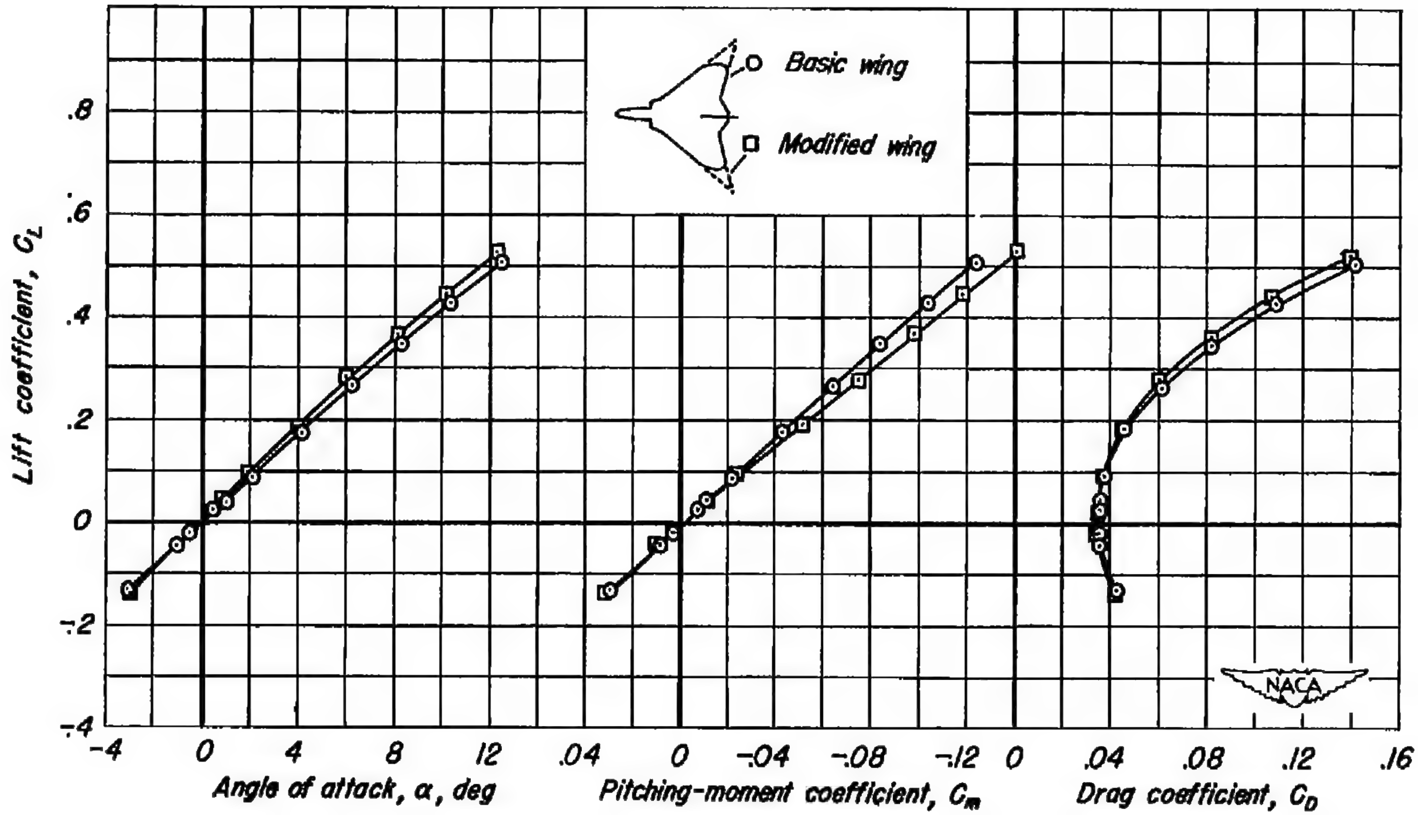
(a) M = 0.90

Figure 5.- Variation of the aerodynamic characteristics with lift coefficient for the basic-wing and modified-wing models. Reynolds number, 2.0 million (nominal).



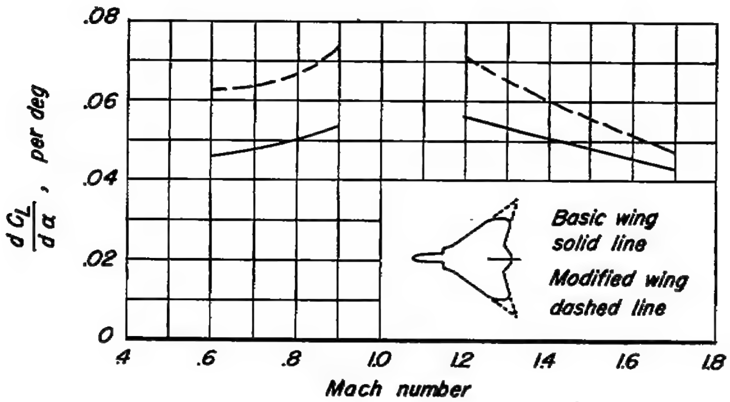
(b) M = 1.20

Figure 5.— Continued.

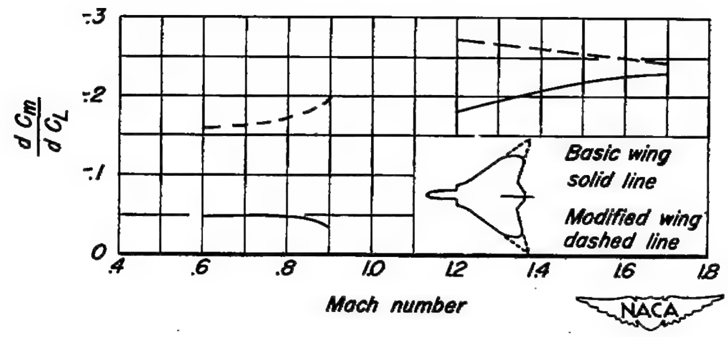


(c) M = 1.70

Figure 5.– Concluded.



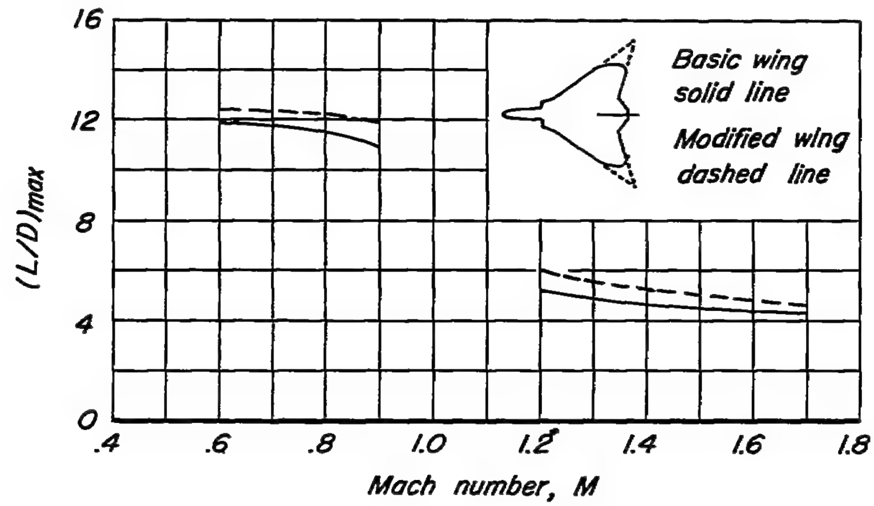
(a) $\frac{d C_L}{d \alpha}$ vs M



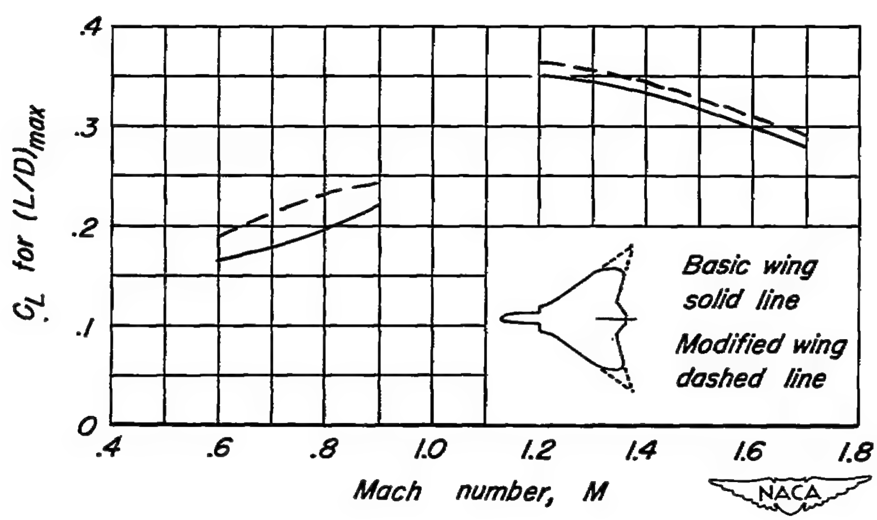
(b) $\frac{d C_m}{d C_L}$ vs M

Figure 6.– Summary of aerodynamic characteristics of the basic-wing and modified-wing models as functions of Mach number. Reynolds number, 2.0 million. (nominal).

[redacted]



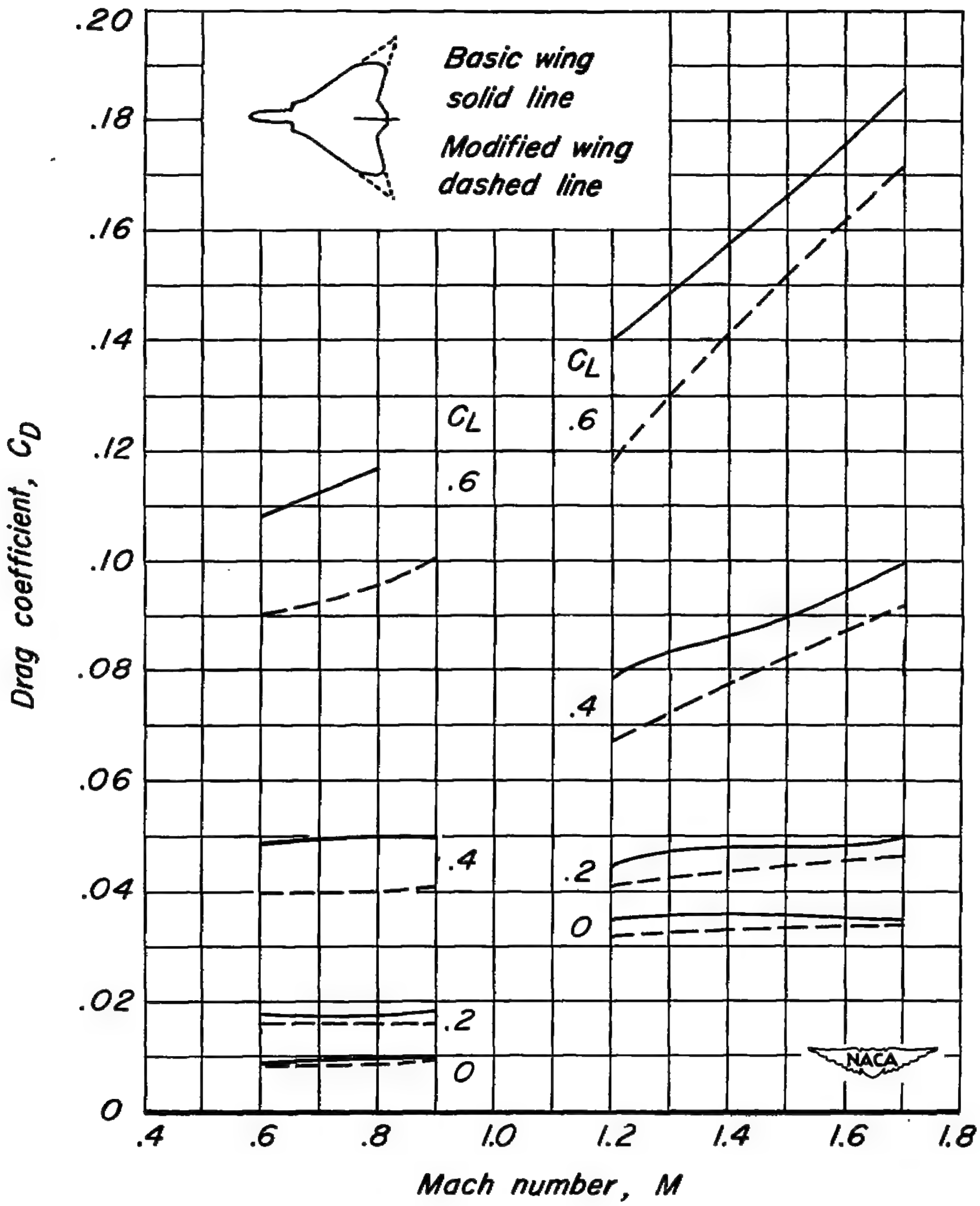
(c) $(L/D)_{max}$ vs M



(d) C_L for $(L/D)_{max}$ vs M

Figure 6.— Continued.

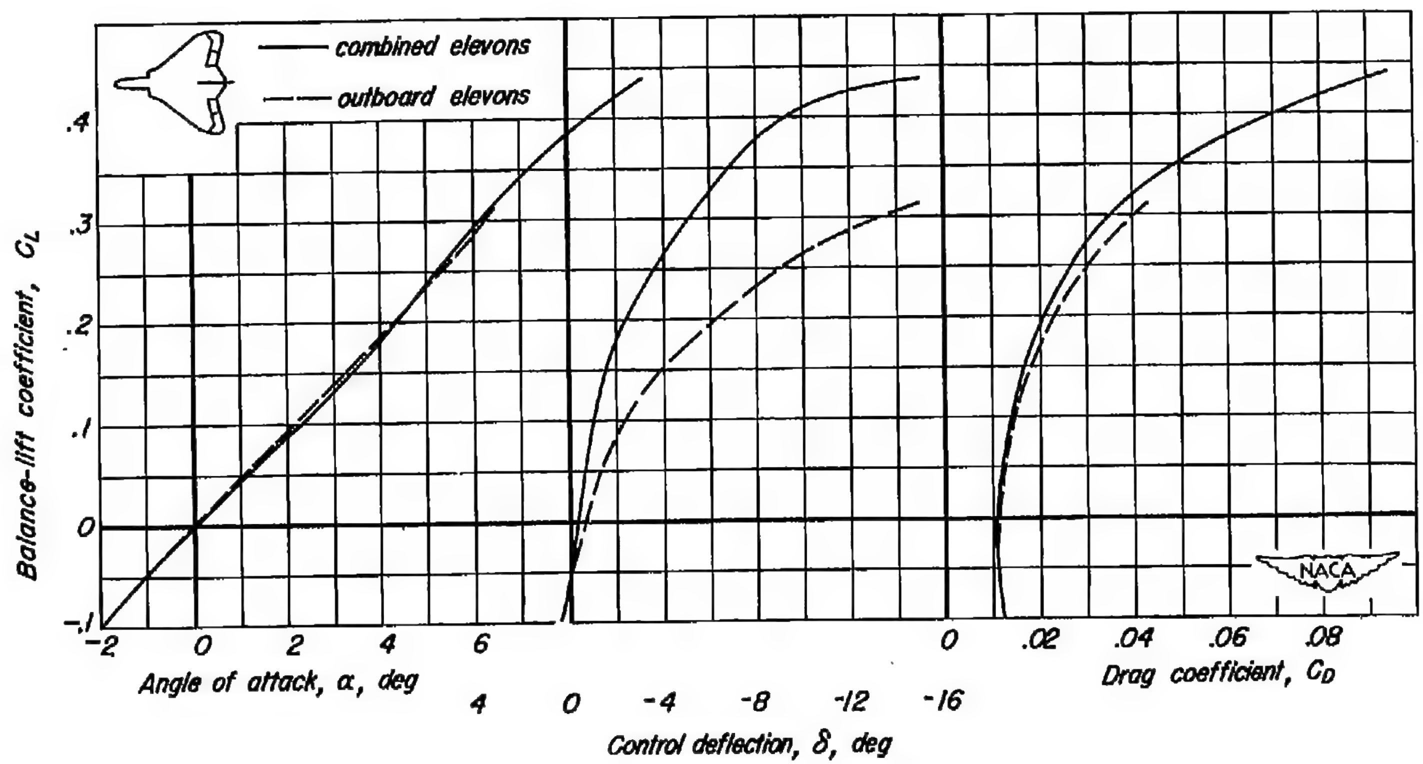
[redacted]



(e) C_D vs M

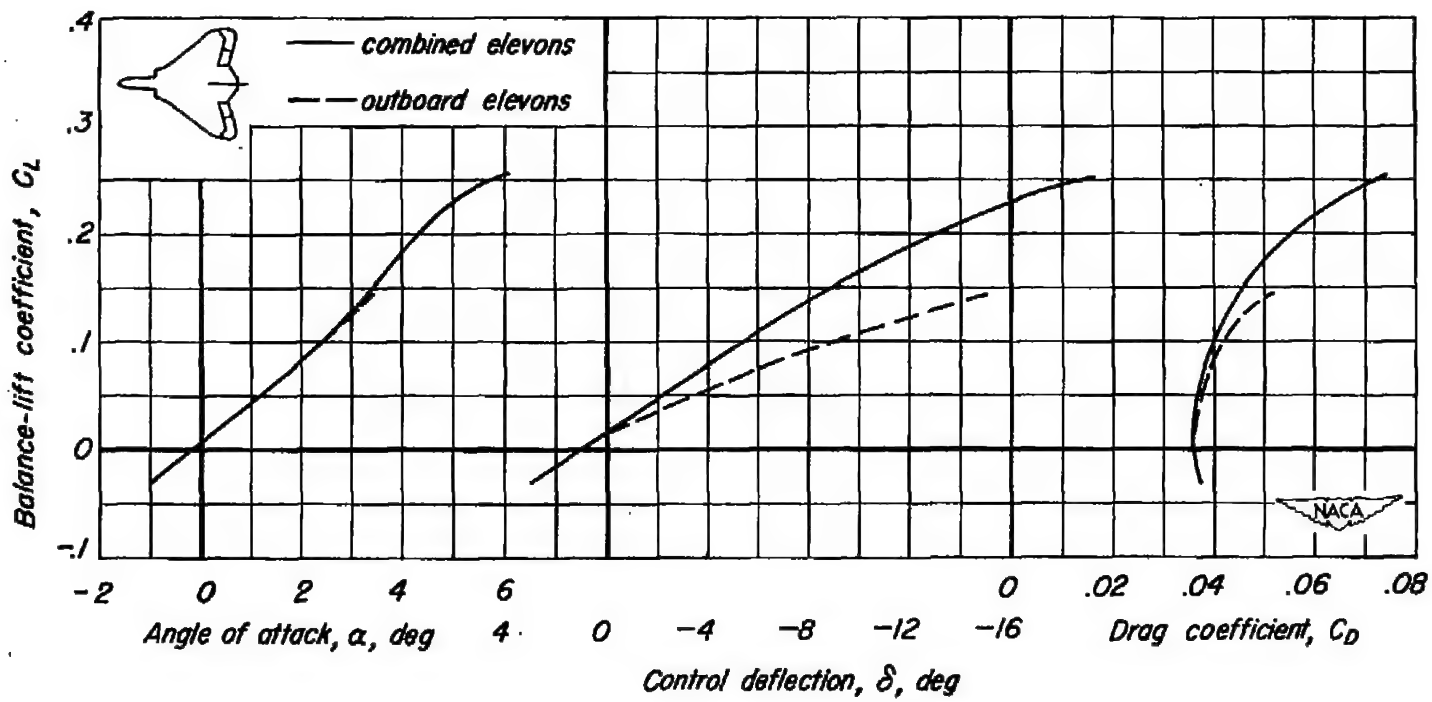
Figure 6.– Concluded.

[redacted]



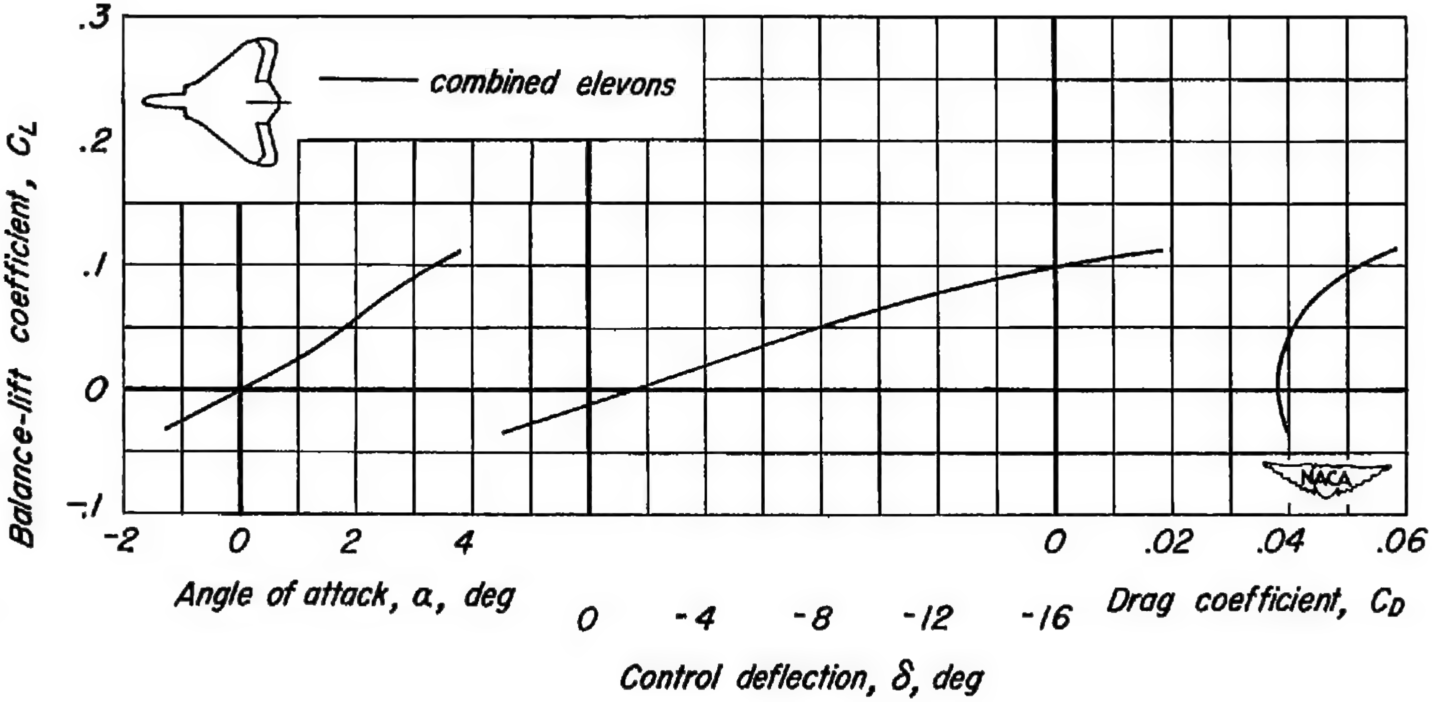
(a) M = 0.90

Figure 7.– Relationship of balance lift coefficient to angle of attack, elevon deflection angle, and drag coefficient for the basic-wing model. Reynolds number, 3.2 million.



(b) M = 1.20

Figure 7.— Continued.



(c) M = 1.70

Figure 7.– Concluded.

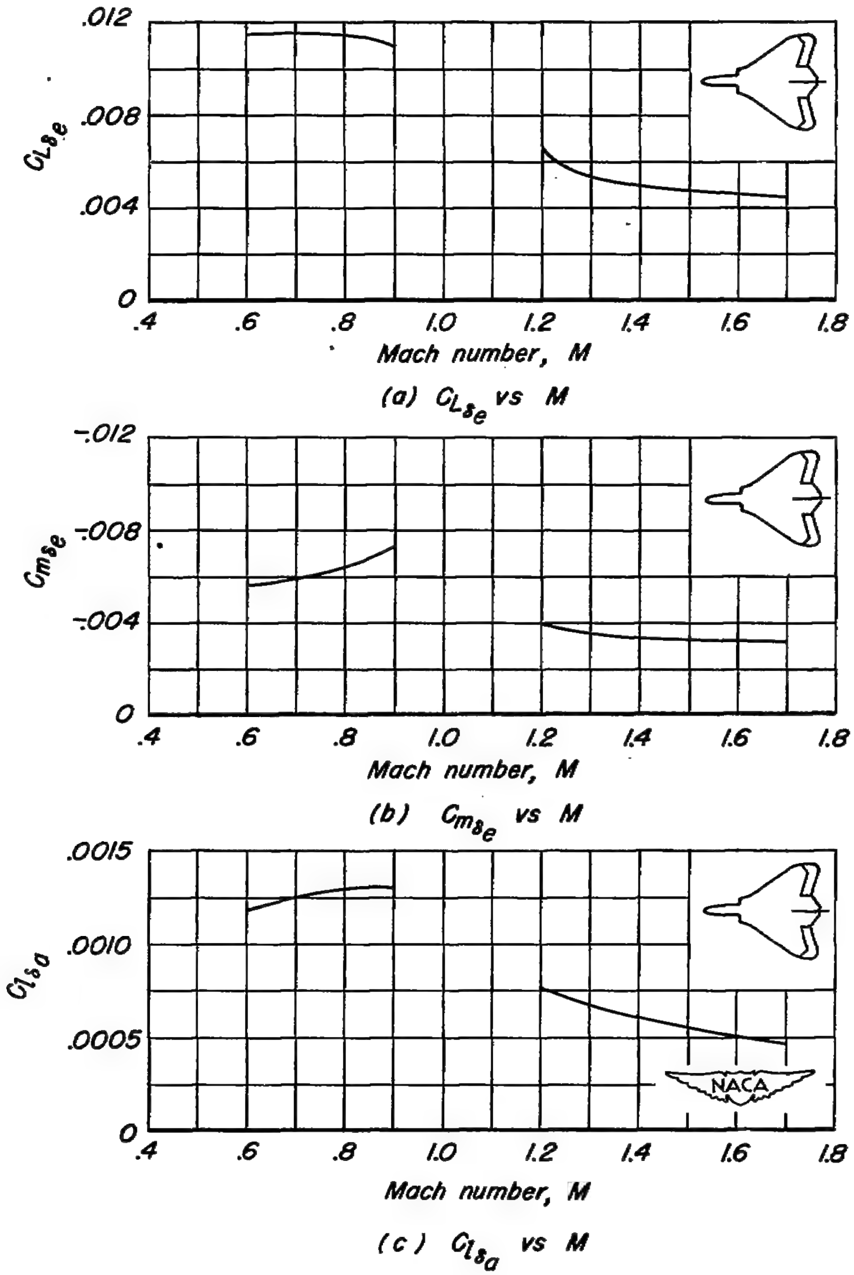


Figure 8.– Summary of elevon effectiveness characteristics at zero lift coefficient as functions of Mach number. Reynolds number, 3.2 million.

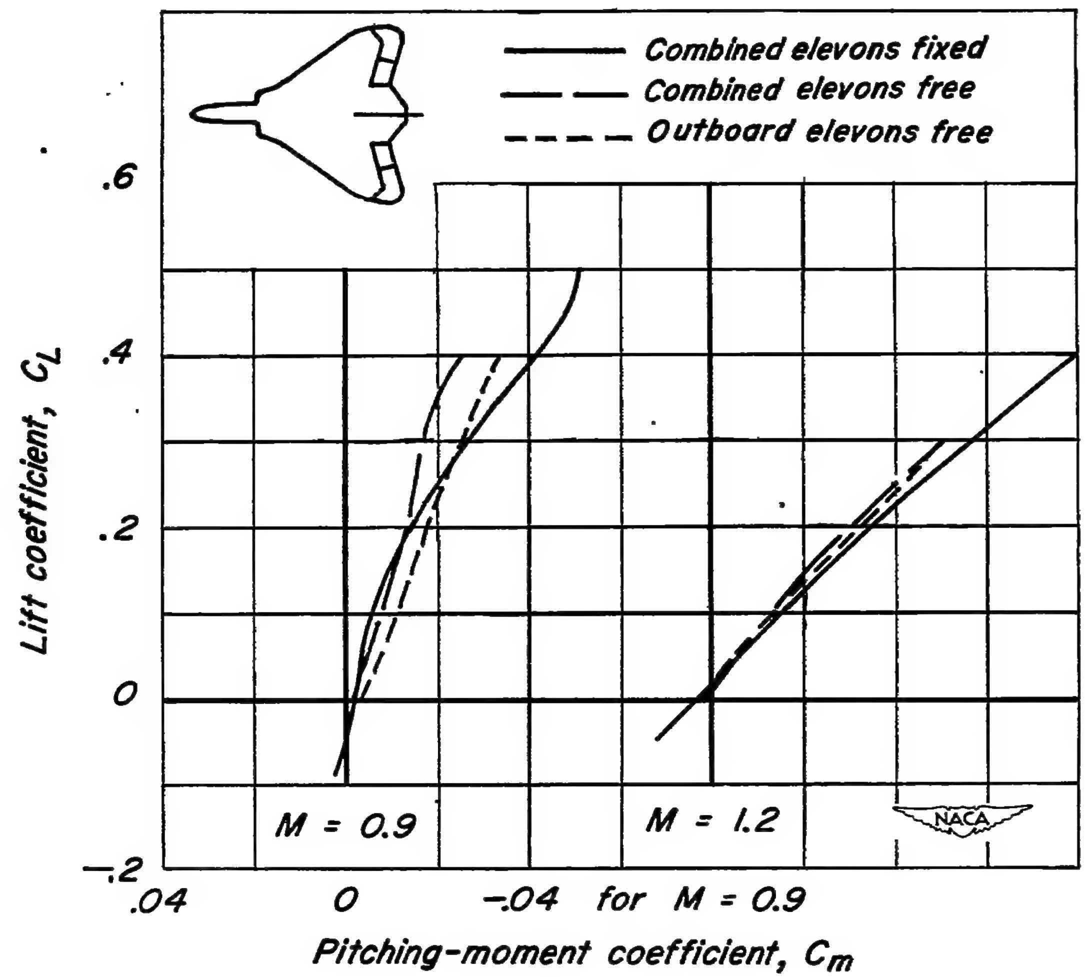
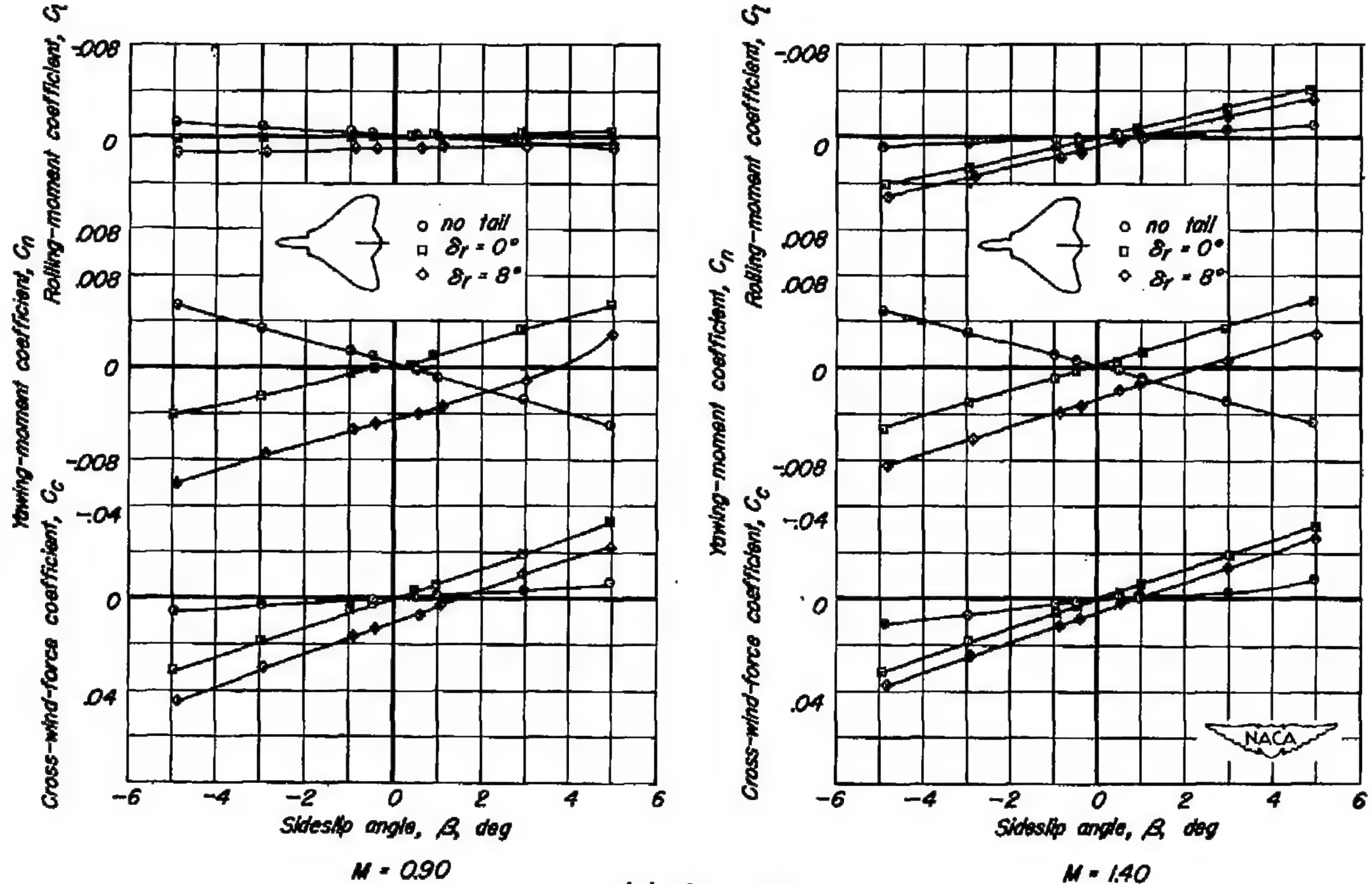


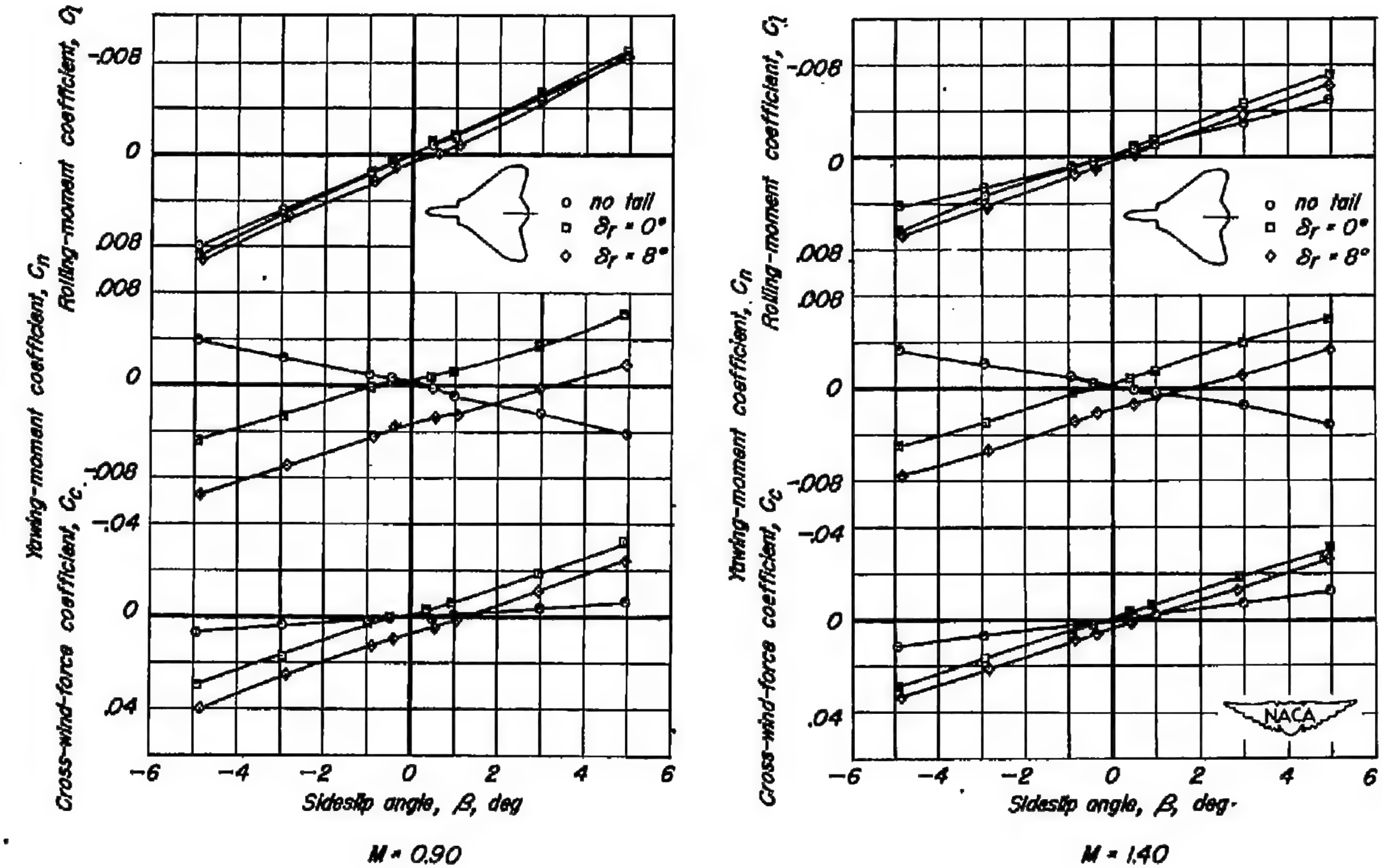
Figure 9.—The variation of pitching-moment coefficient with lift coefficient for the model with controls free and controls fixed at zero deflection. Reynolds number, 3.2 million.

[redacted]



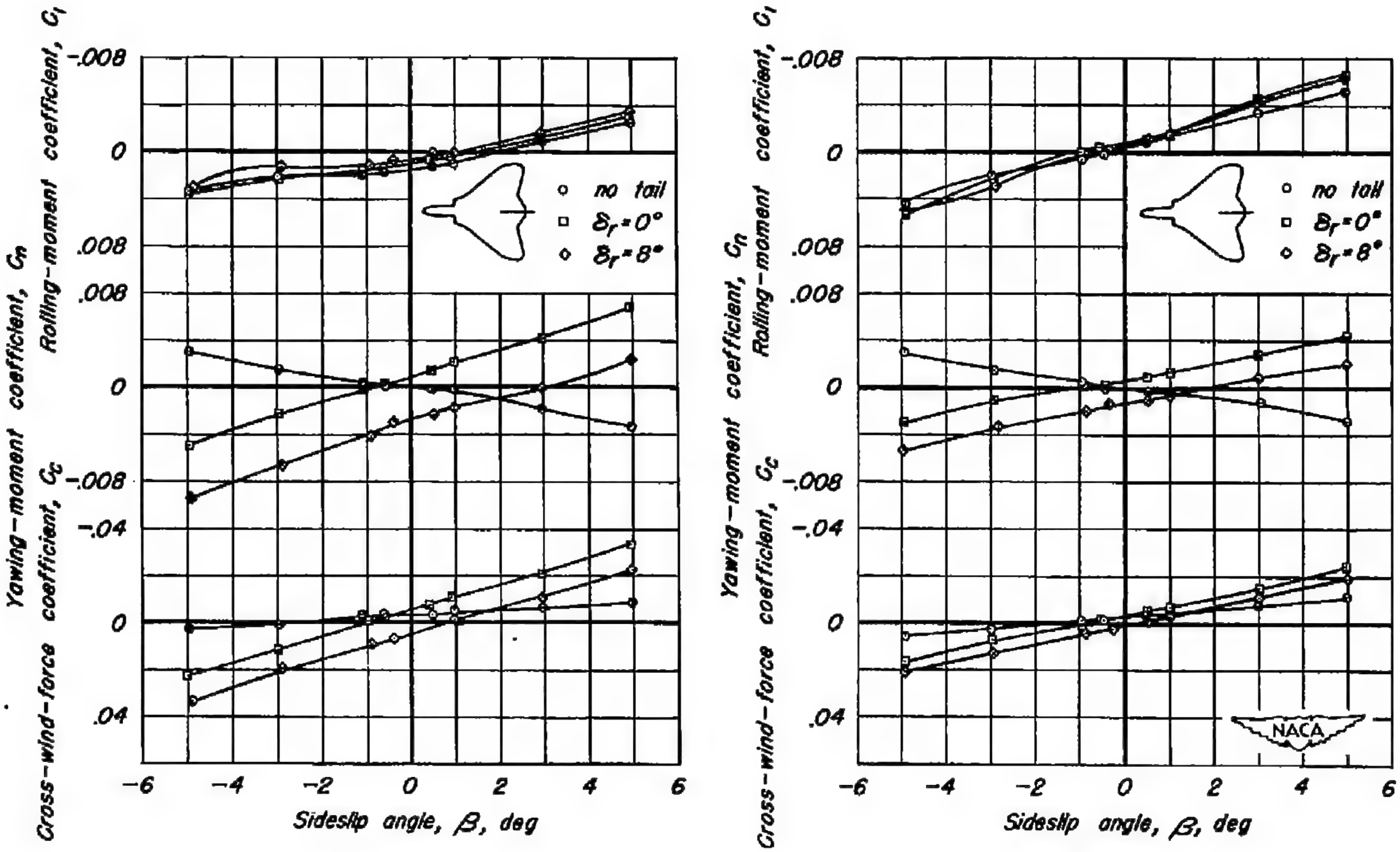
(a) α = −0.5°

Figure 10.–Variation of the lateral stability characteristics with sideslip angle for basic-wing model with the rudder deflected and undeflected, and with the vertical tail removed. Elevons undeflected, Reynolds number, 3.2 million.



(b) α = 5.1°

Figure 10.— Continued.

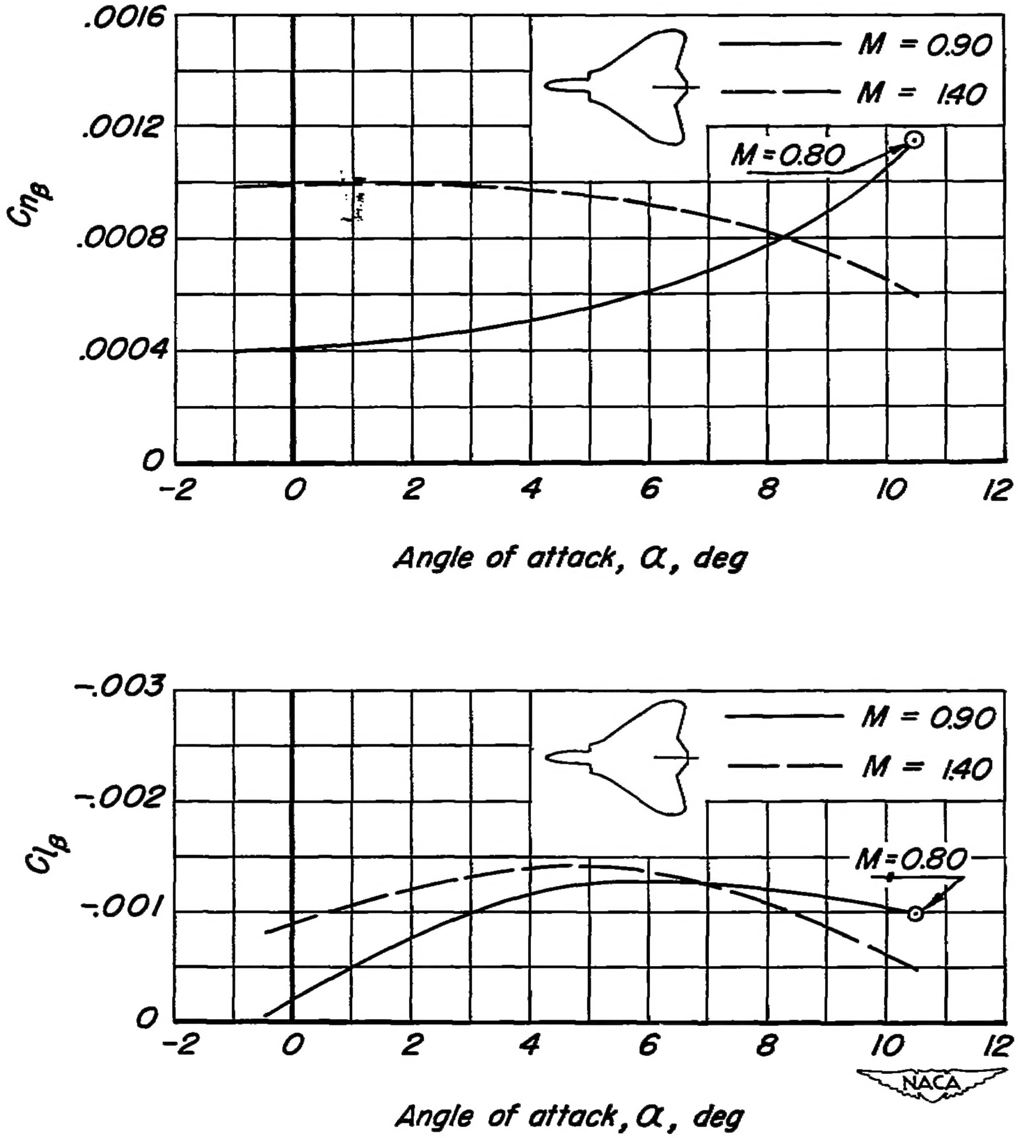


M = 0.80 M = 1.40

(c) $\alpha = 10.5°$

Figure 10. — Concluded.

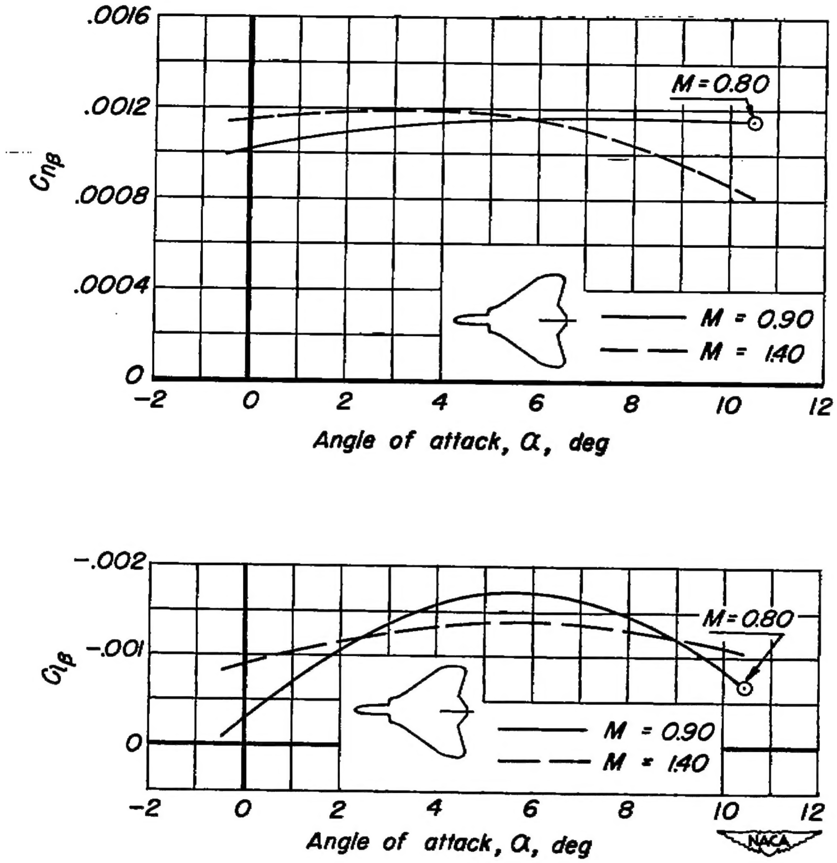
[redacted]



(a) $\beta = 0°$

Figure 11.- The variation of the lateral stability characteristics with angle of attack for the basic-wing model with rudder and elevons undeflected. Reynolds number, 3.2 million.

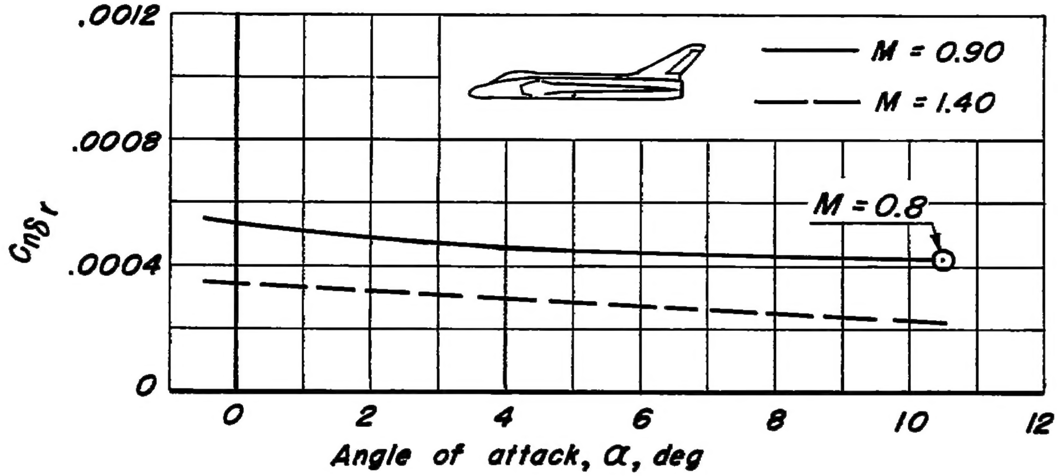
[redacted]



(b) $\beta = 2°$

Figure 11.– Concluded.

[redacted]



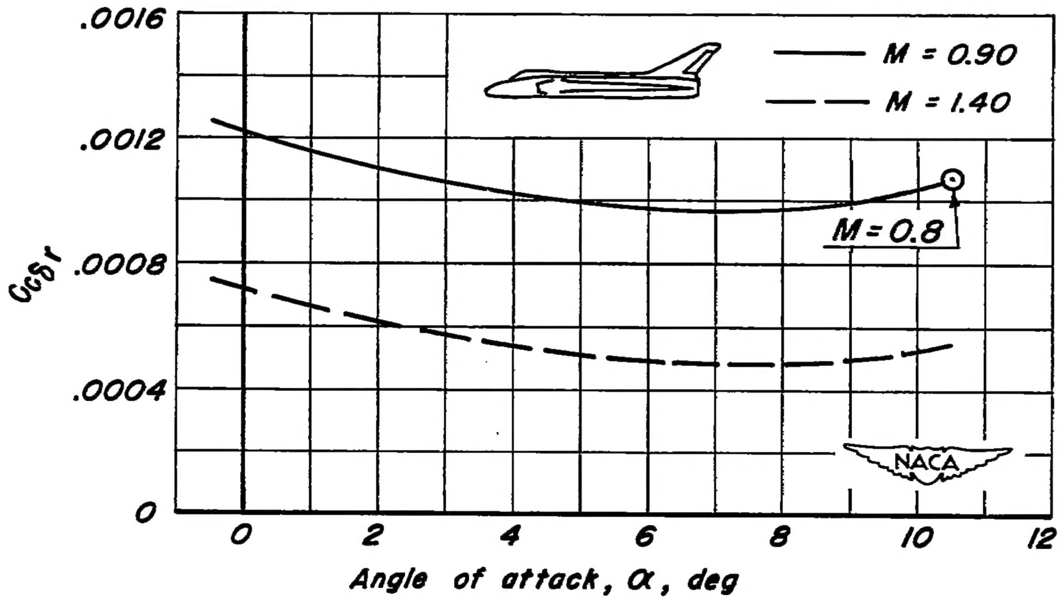


Figure 12.-Variation of the rudder effectiveness characteristics with angle of attack for the basic-wing model with elevons undeflected. Reynolds number, 3.2 million.

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SECURITY INFORMATION

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